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Automated biomechanical analysis system for detection and correction of postural deviations in patients and for providing posture health care through distributed system (Eng)

BIOTONIX INC 2000.11.17 2000US-714830

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2001.11.19 2001WO-CA01649 N(AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH CN CO CR CU CZ DE DK DM DZ EC EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ OM PH PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZM ZW) R(AT BE CH CY DE DK EA ES FI FR GB GH GM GR IE IT KE LS LU MC MW MZ NL OA PT SD SE SL SZ TR TZ UG ZM ZW)

Novelty: Marker positions are selected, referenced with respect to the anatomy of the patient and a scannable marker is fixed to the patient at each point. The patient is then placed in a relaxed and normal standing posture and the markers are scanned to obtain position data for each of the marker positions. The data are used to calculate postural deviation values.

Detailed Description: INDEPENDENT CLAIMS are included for the following:

(1) a method of acquiring biomechanical postural data;

(2) a method and apparatus for calculating postural deviation;

(3) an apparatus for providing postural health care.

Use: Automated biomechanical analysis for detection and correction of postural deviations.

Description of Drawing(s): The drawing shows anatomical marker locations in an anterior view.

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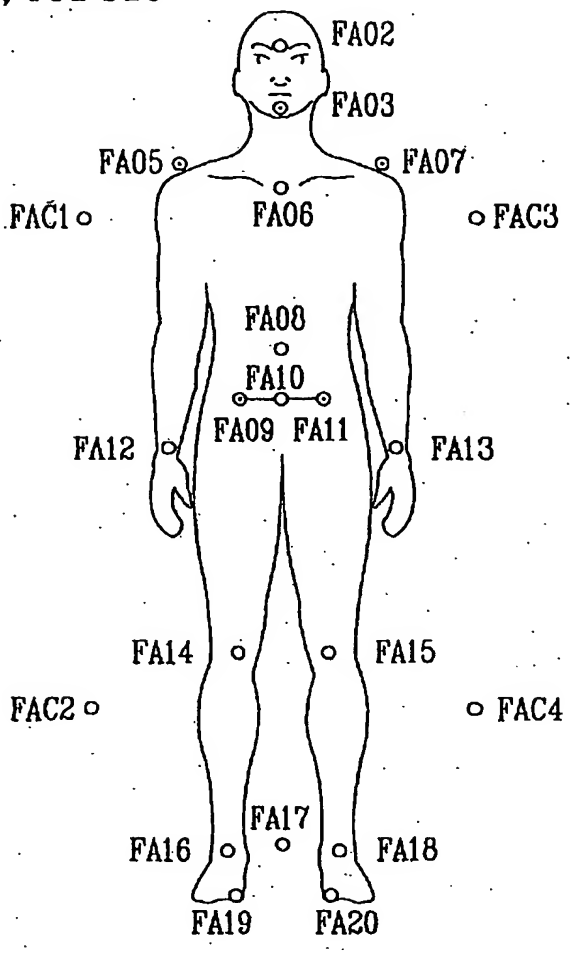

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(54) Title: SYSTEM AND METHOD FOR AUTOMATED BIOMECHANICAL ANALYSIS AND THE DETECTION AND CORRECTION OF POSTURAL DEVIATIONS

(57) Abstract: The present invention relates to a method and apparatus of acquiring biomechanical position data for use in postural analysis. The present invention also relates to a method and apparatus for calculating postural deviation values in a patient. The present invention further relates to a method and apparatus of providing posture health care using a distributed system.

SYSTEM AND METHOD FOR AUTOMATED BIOMECHANICAL ANALYSIS AND THE DETECTION AND CORRECTION OF POSTURAL DEVIATIONS

The present invention relates to a system and method for the biomechanically accurate measurement of posture and for providing a patient with a suitable corrective exercise program. More particularly, the present invention relates to a system and method to automatically analyse the location of anatomical markers placed over skeletal landmarks to obtain biomechanical parameters; a system and method that uses these biomechanical data to automatically detect and/or quantify postural deviations from correct anatomical alignment; a system and method to automatically generate corrective exercise routines. The present invention also relates to the use of the Internet to provide a distributed system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback between the patient and either the health-care professional or the central server or both.

BACKGROUND OF THE INVENTION

Description of Prior Art

A tree trunk grows straight up and tree branches are symmetrical around this solid core to provide a "posture" to withstand the effects of wind and gravity. We too have an optimal posture that allows us to function most efficiently. As builders and architects use plum lines to arrange the walls and supporting structures of a home, we use plumb lines to define this ideal postural alignment. In correct posture, a plumb line dropped from you ear will go through your shoulder, the middle of your pelvis, the middle of your knee, and the front of your anklebone. Your head, trunk, pelvis and knees are "stacked" one on top of the other. Deviations from this positioning can have negative consequences to your health and well being, and correcting postural alignment can make a person look and feel better. Ideal or optimal posture minimizes energy expenditure and muscle work necessary to maintain deviant posture in the face of gravitational forces. As patients become more and more proactive in their choice or health care, they will certainly demand amelioration of their disordered posture. For example, lower back pain has often been attributed to abnormal postural relationships between body segments, and is frequently a cause of patient complaints to family care physicians.

Typically, practitioners are content with a basic appreciation of a client's posture. Systematic biomechanical analyses are rarely performed because they are time intensive and require specialized equipment. Instead, only qualitative observations are often made. Specialists, such as Chiropractors and physiotherapists are sometimes trained to make postural assessments, often employing qualitative measures to assess posture and determine corrective measures. Practitioners may refer to these specialists, but again, the procedures are time and labor intensive and consequently, are expensive for the patient, who may or may not have insurance to cover these expenses. Further, qualified medical practitioners, such as family practice physicians, may want to perform such analyses but lack the specialized equipment or training to accurately assess posture based on observations alone. Consequently, a cost effective and highly automatic system is needed to assist practitioners in effective assessment and treatment of postural difficulties.

Another deficiency of the actual method to evaluate and correct patient's posture is the loss of control of the health-care practitioner in the treatment given to his or her patient when he or she refers the patient to a specialist such as chiropractor or physiotherapist. The patient has to take several appointments from several potential specialists. Furthermore, no health-care practitioner or specialist alone can benefit from experience with thousands of patients and be able to correlate biomechanical information from these patients with appropriate treatment and results obtained. There is neither a way to share experience in an efficient way between several health-care practitioners and/or specialists treating this many patients. There is also no way to provide a quantified follow-up of progress.

SUMMARY OF THE INVENTION

One aim of the present invention is to provide a process and apparatus to acquire biomechanical position data in selecting marker positions referenced with respect to the patient's skeletal anatomy by one of skin surface features having minimal variability from one patient to the next and skeletal features palpable from a skin surface of the patient and in attaching a scanable marker on the patient at each of the marker positions, these marker positions being used to calculate the positions of body segments.

Another aim is to provide a method and apparatus to analyze these body segment positions to obtain body segment biomechanical parameters and deviations.

Another aim of the present invention is to provide a method and apparatus to use these biomechanical deviation values to determine postural deviations and corrective exercises to rectify these deviations.

Another aim of the present invention is to use the Internet to provide a distributed system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback between the patient and either the health-care professional or the central server or both.

In accordance with the present invention there is provided a method of acquiring biomechanical position data for use in postural analysis, this method comprising the steps of:

a) selecting a plurality of marker positions referenced with respect to an anatomy of a patient by one of:

- skin surface features having minimal variability from one patient to the next; and
- skeletal features palpable from a skin surface of the patient;

b) attaching a scanable marker on the patient at each of the marker positions, the step of attaching including palpating the patient to define at least some of the marker positions;

instructing the patient to stand relaxed and in normal posture; and

c) scanning the markers on the patient to obtain position data for each of the marker positions.

The method in accordance with a preferred embodiment of the present invention, wherein the patient is scanned from a front, side and rear viewpoints.

The method in accordance with a preferred embodiment of the present invention, wherein the step of scanning comprises photographing the patient against a backdrop, the markers comprising contrasting visual markers, the backdrop including a plurality of scale and orientation reference marker points.

The method in accordance with a preferred embodiment of the present invention, wherein the markers comprise an adhesive layer for sticking to the patient.

The method in accordance with a preferred embodiment of the present invention, wherein the step of photographing comprises using a digital camera with a flash to obtain digital images, the markers comprising retroreflective markers.

The method in accordance with a preferred embodiment of the present invention, wherein some of the markers are scanned from more than one of the viewpoints and comprise retroreflective spheres.

The method in accordance with a preferred embodiment of the present invention, wherein the step of instructing the patient to stand relaxed and in normal posture comprises requesting the patient to walk in place prior to standing still.

The method in accordance with a preferred embodiment of the present invention, wherein the step of scanning comprises automatically recognizing the markers and the reference marker points in the digital images using a computer.

The method in accordance with a preferred embodiment of the present invention, wherein the computer comprises a user interface and, when the computer recognizes too many or too few of the markers, input is accepted via the user interface to remove or add, with reference to the digital images, the position coordinates of the markers which the computer incorrectly recognized or failed to recognize.

In accordance with the present invention, there is provided a method for calculating postural deviation values in a patient comprising the steps of:

a) obtaining position data identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles;

b) obtaining height and weight data of the patient;

c) calculating vertical and horizontal plumb lines using the position data;

d) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb lines using the position data.

The method in accordance with a preferred embodiment of the present invention, wherein the angle and distance of deviation values are referenced with respect to average or normal values.

The method in accordance with a preferred embodiment of the present invention, further comprising a step of calculating an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.

The method in accordance with a preferred embodiment of the present invention, wherein the deviation values are calculated for all of the body segments.

In accordance with the present invention there is provided a method of selecting exercises for improving tonicity and correcting posture in a patient, the method comprising the steps of:

a) obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data indicative of postural problems requiring correction;

b) ranking the postural deviations by severity and priority;

c) correlating the position data with exercises for strengthening or stretching specific muscles or muscle groups to obtain ranking data for the exercises;

d) compiling an exercise program for the patient based on the ranking data.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises manually selecting exercises from a ranked list of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the

position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the position data identifies a position in space of body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the step of correlating comprises:

a) calculating vertical and horizontal plumb lines using the position data;

b) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb lines using the position data;

c) comparing the deviation values to normal values for the at least some of the body segments to obtain deviation priority values;

d) ranking the deviation priority values according to an order of severity or importance; and

e) determining the ranking data based on an association of the exercises with body segment deviations in accordance with the order of severity or importance.

The method in accordance with a preferred embodiment of the present invention, wherein the step of ranking the deviation priority values according to an order of severity or importance comprises manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations manually selected.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, and the exercise program comprising a series of the sets of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the exercise program is limited to a maximum number of exercises, the step of manually selecting deviations is automatically restricted when a maximum number of exercises corresponding to the selected deviations exceeds the maximum number for the exercise program.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

The method in accordance with a preferred embodiment of the present invention, further comprising steps of:

a) obtaining, after completing of the exercise program, new biomechanical position data of the patient while standing relaxed and in normal posture;

b) evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems; and

c) adjusting parameters used in the step of correlating for future patients based on the effectiveness evaluated in the previous step.

The method in accordance with a preferred embodiment of the present invention, wherein the exercise program is repeatedly varied until the effectiveness of the exercises is optimized.

The method in accordance with a preferred embodiment of the present invention, wherein the steps of correlating, evaluating and adjusting are carried out using a centralized shared database of the parameters used in the step of correlating for a large number of patients.

The method in accordance with a preferred embodiment of the present invention, wherein the parameters include at least one of age and an activity level of the patient.

In accordance with the present invention there is provided a method of providing posture health care using a distributed system, the method comprising the steps of:

a) obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;

b) processing the personal and position data using data stored in a remote central database to obtain preliminary postural deviation assessment data;

c) providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;

d) obtaining corrected postural deviation assessment data from one of the health-care practitioner and the patient; and

e) modifying the data stored in the central database using the corrected data.

The method in accordance with a preferred embodiment of the present invention, wherein the preliminary postural deviation assessment data comprises a ranked list of deviations and a preliminary selection of the deviations to be included in a therapeutic exercise program, and the corrected data comprises a corrected selection of the deviations to be included in a therapeutic exercise program.

The method in accordance with a preferred embodiment of the present invention, wherein:

the preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

the corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

step (e) comprises processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and modifying accordingly the data stored in the central database.

The method in accordance with a preferred embodiment of the present invention, wherein:

step (a) comprises validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a central server;

step (b) is a carried out at the central server;

step (c) comprises transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;

step (d) comprises transmitting the corrected data to the central server; and

step (e) is carried out by the central server.

The method in accordance with a preferred embodiment of the present invention, wherein the biomechanical measurement station includes a health-care practitioner client station in communication with the central server.

The method in accordance with a preferred embodiment of the present invention, wherein the client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

For the purpose of the present invention the following terms are defined below.

The term "anterior view" is intended to mean the view of the front of the body (with the person in anatomical position). The term "lateral view" is intended to mean the view of the patient from the side.

The term "posterior view" is intended to mean the view of the patient from behind.

The term "body segment parameters" is intended to mean the spatial coordinates of body segments and key anatomical landmarks taken from the images from the lateral, anterior and posterior views.

The present invention provides a process and apparatus to acquire patient images rapidly and accurately in a clinical environment, to extract body segment parameters from surface markers, a method for analysing these data to obtain biomechanical parameters and deviations, a method involving the use of these biomechanical parameters and deviations for the detection of postural deviations and the selection of corrective exercises, and the use of Internet to provide a distributed system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback between the patient and either the health-care professional or the central server or both. The placement of markers based on a well established model of ideal postural alignment is crucial because the placement of markers determines the relative deviation of body segments from vertical and horizontal "plumb" or ideal alignment. The current system uses the most widely used and respected anatomical definition of ideal postural alignment (Kendall, McCreary, & Provance, 1993). And, a sophisticated marker placement system has been designed to place surface markers on locations defining this alignment. The importance of a correct definition of ideal posture is obvious when one is attempting to detect postural deviations. A further crucial difference between the earlier systems and the present invention is the use of scanning technology to automatically detect the location of reflective markers placed on the skin overlying skeletal landmarks. They can be placed directly on the skin because they are made from a hypoallergenic material. Such marker placement is highly important, because it avoids the potential examiner error associated with the manual identification of presumed skeletal landmarks from video images. The current system automatically detects markers, and their locations are transmitted automatically through the web for the calculation of postural deviations. Further differences between earlier state of the art and the current system includes the automatic generation of a personalized exercise plan based on individualized and automatic assessments of patients' biomechanical and postural status.

As such, the biomechanical knowledge system radically changes the practice of biomechanical analysis by creating an objective and effective methodology that is simple to implement using complex yet innovative technology. We have developed a strong theoretical model of biomechanical function as well as innovative methods for data capture, analysis and adapted exercise routines. Both theoretical and technological aspects of our system have been integrated into a coherent and operational system.

We have successfully linked a biomechanical assessment of potential postural deviations to the underlying muscular components giving rise to these deviations. We go further by suggesting specific muscular training routines to ameliorate the underlying muscular and postural deviations. This unique theoretical and methodological link will be outlined in more detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and wherein:

Fig. 1: surface anatomical marker locations in the anterior view;

Fig. 2: marker positions in the lateral view;

Fig. 3: marker positions in the posterior view;

Fig. 4: the retroreflective marker sticker construction according to the preferred embodiment;

Fig. 5: the retroreflective marker sphere and application sticker assembly according to the preferred embodiment;

Fig. 6: the position of the camera and calibration backdrop;

Fig. 7: the perspective of the subject relative to the wall and the camera, as well as measures used for calculations;

Fig. 8: the flowchart describing the image acquisition and the obtention of the location of anatomical markers;

Fig. 9 shows the flowchart describing the process to generate an exercise schedule;

Fig. 10: the flowchart describing the overall process of biomechanical assessment, postural deviation detection, exercise generation, feedback from health-care practitioner to patient and follow-up.

Fig. 11: the schema server-user;

Fig. 12: description of missing marker calculation;

Fig. 13: page of the Biomechanical Assessment Report (Biomechanical Assessment Report) with patient's image, deviations and biomechanical parameters;

Fig. 14: page from the Biomechanical Assessment Report with postural deviations and associated exercises and stretching;

Fig. 15: page from the Biomechanical Assessment Report with exercise schedule; and

Fig. 16: page from the Biomechanical Assessment Report with illustration and description of two of the many possible exercises of the exercise program

DETAILED DESCRIPTION OF THE INVENTION

In accordance with the present invention, there is provided a system and method using biomechanical analysis to generate a schedule of corrective exercises suitable for a patient's condition.

The present invention follows the established biomechanical and clinical principle that resting, standing posture is a composite state made up of the relative position of body segments (e.g., head, trunk, legs) in space and relative to gravity. This is known as static postural alignment. Posture can also be described in terms of muscular balance. Proper posture is the result of symmetrical muscular development and the appropriate interaction of flexor and extensor muscles in a way that suits a vertical stance.

The method described in the present application is based on hypotheses underlying muscular balance, such hypotheses being that:

- All alignment problems yield abnormal tension and constrain the skeleton, joints, ligaments and muscles.

- The study of the relative position of linked body segments reveals muscles that are hyper- or hypo-contracted.
- Alignment and muscular balance are correlated for normal posture.
- Muscular imbalance promotes an increase in the distance of a body segment from correct vertical and horizontal alignment.
- Depending on the deviation, antagonist muscle groups must be strengthened or stretched to achieve correct muscular balance and postural change.

The inseparable qualities that are alignment and muscular balance are central components of correct body mechanics. A correct vertical stance is the result of a harmonious combination of joint and body segment positions, which in turn stem from an optimal ratio of agonist/antagonist muscles. The energy expenditure required by the muscles is minimal. Therefore, there is an optimal alignment of the body that must take into account all anatomical structures involved in maintaining this alignment. Further, alignment is maximal when the load-bearing structures are also positioned optimally relative to gravity. The sum of forces that act on anatomical structures are balanced if the body is correctly positioned. Daily activities and habits often transform the body from ideal postural alignment independently of disease or structural anomalies. This can have highly negative consequences on daily living, and particularly in terms of the energy necessary to maintain the disordered posture and overlying movements. It is therefore very important to identify and correct these postural deviations.

The following steps are involved in the postural assessment-postural deviation muscular identification-exercise process. These steps consists of:

- Comprehensive biomechanical analysis
- Identification of postural deviations and ranking by order of priority
- Specification of muscular factors underlying the postural deviations
- Personalised muscular stretching and exercises routines to ameliorate postural deviations that incorporates level of difficulty and order of priority of deviations

- Assessment of client progress by follow-up Biomechanical Assessment Reports and
- Modification of exercise protocol, if necessary.

The marker construction according to the preferred embodiment is illustrated in Figs. 4 and 5. There are two types of markers, flat round disks 25 and spheres 30. The disks 25 and spheres 30 share the same diameter, namely about 2 cm. The spherical and flat markers are placed on the surface of a patient's body using hypoallergenic adhesive, the markers being placed over skeletal landmarks that define ideal postural alignment. The skeletal landmarks used in the present invention are landmarks which have been recommended by the teachings of Kendall et al. (1993) mentioned above. The adhesive layer 24 is provided on a release sheet 20 with a lift-off tab 24. The retroreflective disk 25 is already attached to the adhesive sheet 22 which has the same shape as the disk, except for the tab 24. Due to the double-sided adhesive sheet 22, the adhesive layer 21 is hypoallergenic and is used to contact the skin or the tight clothing of the patient 36, while the adhesive layer 23 allows the disk 25 to be held in place or peeled off. When the disk 25 is peeled off, the sheet 22 remains adhered to the patient surface 36, and exposes the layer 23. The sphere 30, having a truncated flat side is adhered to layer 23, and is thus applied to patient surface 36. The sphere 30 comprises a wooden core 32 which is dipped in a retroreflective paint (Axon Alert 1460, Axon Aerospace, Greenville, U.S.A.) which forms a coating 34.

The disk 25 is cut from stock sheet of retroreflective material made by 3M, namely 3929 Thermal Transfer Printable Retro-Reflective Label Stock and has a thickness of 3 mm. The double-sided adhesive sheet 22 is made by 3M, namely 1522, Double Coated Medical Tape. The adhesive layers 21 and 23 are hypoallergenic, pressure sensitive acrylate adhesive. The coating material 34 comprises 85% solids per weight and the fineness of grind is 200 mesh. The mixing and coating process is as follows. Surfaces to be paint are cleaned and lightly abraded before coating. The spheres are then dipped between 2 to 5 minutes and dried under normal drying conditions.

Four digital images are taken of the patient using camera 10 in order to provide a visual image of postural alignment for the patients and health-care

professionals and for the automatic detection of body segment parameters. The camera 10 has a standard built-in flash 12 which is set to operate during image acquisition. The intense light form the flash is reflected by the markers 25 and 30 and the markers appear as bright small circles in the acquired images. The high contrast of the markers 25 and 30 with respect to the image of the patient facilitates later automatic recognition of the markers. The placement of markers in the anterior view is shown in Fig. 1. FA02 is a spherical marker placed on the glabella, FA03 is a spherical marker placed on the middle of the chin and overlying the mental protuberance, FA05 is a spherical marker placed on the right shoulder over the acromion, FA07 is a spherical marker placed on the left shoulder over the acromion, FA06 is a marker placed on the jugular notch, FA08 is a marker placed over the umbilicus, FA09 is a spherical marker placed on the right anteriosuperior iliac spine, FA11 is a marker placed on the left anterior superior iliac spine, FA12 is a marker placed on the right wrist over the styloid process of the radium, FA13 is a marker placed on the left wrest over the styloid process of the radius, FA14 is a marker centered over the right patella, FA15 is a marker centered over the left patella, FA16 is a marker centered between the right medial and lateral malleoli, FA18 is a marker centered between the left medial and lateral malleoli, FA19 is a marker placed on the anterior aspect of the right distal phalanx of the great toe and FA20 is a marker placed on the anterior aspect of the left distal phalanx of the great toe.

The markers on the lateral view are placed as shown in Fig. 2. SD01 is a marker placed on the tragus of the right ear, SD02 is a spherical marker placed on the glabella, SD03 is a spherical marker placed on the middle of the chin, and overlying the mental protuberance, SD04 is a spherical marker placed on the right shoulder over the acromion, SD05 is a spherical marker placed over the right posterior superior iliac spine, SD08 is a spherical marker placed on the right anteriosuperior iliac spine, SD09 is a marker placed over the greater trochanter, SD10 is a marker placed on Gerdy's tubercle and SD11 is a marker placed on the transverse tarsal joint.

The markers on the posterior view are placed as shown in Fig. 3. FP03 is a marker placed over the spinous process of the seventh cervical vertebra, FP04 is a spherical marker placed on the left shoulder over the acromion, FP05 is a spherical marker placed on the right shoulder over the acromion, FP06 is a marker placed over the spinous process of the fifth thoracic vertebra, FP07 is a marker placed over the left

posterior superior iliac spine, FP08 is a spherical marker placed over the right posterior superior iliac spine, FP10 is a marker placed on the left wrist over the styloid process of the ulna, FP11 is a marker placed on the right wrist over the styloid process of the ulna, FP12 is a marker placed over the center of the left popliteal cavity, FP13 is a marker placed over the center of the right popliteal cavity, FP14 is a marker centered over the left Achilles tendon at the level of the medial malleolus, FP16 is a marker centered over the right Achilles tendon at the level of the medial malleolus, FP17 is a marker centered over the calcaneous of the left foot and FP19 is a marker centered over the calcaneous of the right foot.

Precise position of the markers is essential for accurate biomechanical assessment and detection of postural deviations. For this, the patient must wear very tight workout clothes to avoid hiding the few landmarks that are potentially covered by clothing. Most markers are placed directly over the body surface. The health-care practitioner must palpate the patient to make sure that the markers are well positioned.

Shown in Fig. 6 is the position of the camera and calibration backdrop. Pictures are taken with a flash to use the retroreflective property of the markers and make them more apparent on the pictures. The first picture is taken from the lateral view with arms down. The second picture is also from the lateral view but with the proximal arm flexed at 90° to detect the position of markers potentially hidden with the arm down. These values are eventually transferred to the more "natural" lateral image with the arm down. The third and fourth pictures are taken from the anterior and posterior views, respectively. The pictures are taken against a backdrop including a plurality of scale and orientation reference marker points facilitating body segment parameters calculation. Also the patient is instructed to stand in a relaxed and normal posture. To help the patient to adopt the most natural body posture possible, the patient is asked to walk in place prior to standing still.

The digital images are stored on a flash memory card within the camera and then transferred to a card reader connected to a computer which in turn, is connected to the Internet. The health-care professional can then connects to the central processing server (4) of Fig. 12 entering on the system web site. First step, the health-care practitioner has to identify client. If the client has his or her first evaluation, personal data (height, weight, gender, age, activity level, preferred unit of measurement) is

entered. A client identification number is created to identify client data in the database but protect confidentiality. In the second step, the health-care professional starts the image scanning and biomechanical assessment process. The health-care practitioner selects each patient's images in the directory on the computer. The positions of the anatomical markers that define body segments are scanned and coordinates sent via the Internet to the central server for processing. To protect patient privacy, the images themselves are never sent via the Web, only the coordinates of the markers are transferred.

The digital location of the markers is supplied and the system receives the scan, validates it and sends back a validation message to the health-care practitioner. The health-care professional receives an error message if insufficient or excessive markers are apparent in the automatic scan. A manual function is provided to correct marker placements, if necessary, and the images are re-scanned. If it is determined that the marker position data obtained from the images is flawed, the health-care professional may again acquire the images, possibly after rechecking the marker positioning. As will be appreciated, when the imaging is complete, and after confirming that the marker positions have been validated, the tabs 24 of the adhesive sheets 22 for the markers 25 and 30 facilitate removal of the adhesive sheets from the clothing or skin 36 of the patient (see Fig. 5). Since a large number of markers need to be removed, saving time in their removal allows the patient to finish up quicker and change back into his or her clothes.

The next step is to update credit information, submit it to the system and confirm payment. The system sends back a validation message to the health-care practitioner to proceed.

Further to that step, biomechanical calculations are executed on the central server (4) of the Fig. 11.

The first step is the conversion of images from pixels to actual distances. To do so, the origin is redefined as follow:

$$x' = x - \frac{w}{2}$$

$$y' = \frac{h}{2} - y$$

where w = image width

and h = image height

Then the image rotation is proceed as follow:

$$dx = \left(\frac{C1x - C2x}{2}\right) + \left(\frac{C3x - C4x}{2}\right)$$

$$dy = \left(\frac{C1y - C2y}{2}\right) + \left(\frac{C3y - C4y}{2}\right)$$

$$x'' = x'\frac{dy}{d} - y'\frac{dx}{d}$$

$$y'' = y'\frac{dy}{d} - x'\frac{dx}{d}$$

where $d = \sqrt{dx^2 + dy^2}$

with C1, C2, C3 and C4 being calibration points from the backdrop.

With these calculations it is possible to get coordinate values of the position of anatomical markers relevant to plumb lines in millimetres (or inches with conversion). Shown in Fig. 7 is the perspective needed for this process.

D = Calibration dimension (mm)

c = distance of camera from the wall

s= distance of the subject from the wall

$$D' = D\left(1 - \frac{s}{c}\right)$$

$$x''' = \frac{D'}{d}\left(x'' + \frac{w}{2}\right)$$

$$y''' = \frac{D'}{d}\left(y'' + \frac{h}{2}\right)$$

The calculation of (1-s/c) is obtained with the following formulas : $\tan(\alpha)=\frac{dy}{s}=\frac{y}{c}$

$$dy=\frac{y\times s}{c}$$

Y' =Y-dY

$$y'=y\left(1-\frac{s}{c}\right)$$

The same calculations may be made with respect to x and the distance d' can be calculated as :

$$d'=d\left(1-\frac{s}{c}\right)$$

The calculations made, the coordinates of markers are determined and expressed relative to vertical and horizontal plumb lines. The missing markers positioned in pelvic area are then calculated. Shown below are the equations used to determine marker coordinates and Fig. 12 displays the missing markers on the pelvis area. SD5, SD8, SV5 and SV8 represent the markers on the pelvic area. d is the segment relating SD5 and SD8 and b is the segment relating SD5 and SD9. The angle θ is the angle between the markers SD5 and SD8. In reconstructing a right-angle triangle where d is the hypotenuse, w is the leg facing the hypotenuse and h is the remaining leg of the rectangle.

Plus: FA9(x2'', y2'') and FP9(x1'', y1'')

$$dx=(x2'-x1')$$

$$bx=(x3'-x1')$$

$$dy=(y2'-y1')$$

$$by=(y3'-y1')$$

$$h=(y2''-y1'')$$

$$d=\sqrt{dx^2+dy^2}$$

$$b = \sqrt{bx^2 + by^2}$$

$$\vec{d} \bullet \vec{b} = db\cos\theta = dxbx + dyby$$

$$\theta = \cos^{-1}\left(\frac{dxbx + dyby}{db}\right)$$

$$d^2 = (x2 - x1)^2 + h^2$$

$$x2 = x1 + \sqrt{d^2 - h^2} \quad \text{or} \quad x1 = x2 - \sqrt{d^2 - h^2}$$

$$y2 = y1 + h \quad \text{or} \quad y1 = y2 - h$$

$$w = x2 - x1$$

$$x3 = x1 + \frac{b}{d}(w\cos\theta - h\sin\theta)$$

$$y3 = y1 + \frac{b}{d}(h\cos\theta + w\sin\theta)$$

Marker coordinates are used in the next step to determine a patient's deviations from optimal alignment. Shown in Table 1 are the calculations necessary to determine postural deviations.

Table 1

Code	Related body parts	Formula	Units
FA_ANG1	Shoulders	ARCTAN((FA07Y-FA05Y)/(FA07X-FA05X))	°
FA_ANG2	Pelvis	ARCTAN((FA11Y-FA09Y)/(FA11X-FA09X))	°
FA_ANG3	Knees	ARCTAN((FA15Y-FA14Y)/(FA15X-FA14X))	°
FA_DIST1	Shoulders	((FA05X+FA07X)/2)-FA17X	mm
FA_DIST2	Forehead	FA02X-FA17X	mm
FA_DIST3	Navel	FA08X-FA17X	mm
FA_DIST4	Pelvis	FA10X-FA17X	mm
FA_DIST5	Knees	((FA14X+FA15X)/2)-FA17X	mm
FA_DIST6	Toes	((FA20X+FA19X)/2)-FA17X	mm
FP_ANG_AN1	Left Foot	ARCTAN((FP14X-FP17X)/(FP14Y-FP17Y))	°
FP_ANG_AN2	Right foot	ARCTAN((FP16X-FP19X)/(FP16Y-FP19Y))	°
FP_ANG1	Shoulders	ARCTAN((FP05Y-FP04Y)/(FP05X-FP04X))	°
FP_ANG2	Pelvis	ARCTAN((FP09Y-FP07Y)/(FP09X-FP07X))	°
FP_ANG3	Knees	ARCTAN((FP13Y-FP12Y)/(FP13X-FP12X))	°
FP_DIST1	Shoulders	((FP04X+FP05X)/2)-FP18X	mm
FP_DIST2	7^{th} cervical	FP03X-FP18X	mm
FP_DIST3	5^{th} dorsal	FP06X-FP18X	mm
FP_DIST4	Pelvis	FP08X-FP18X	mm
FP_DIST5	Knees	((FP13X+FP12X)/2)-FP18X	mm
FP_DIST6	Ankles	FP15X-FP18X	mm
SD_ANG1	Head-Shoulders	ARCTAN((SD01X-SD04X)/(SD04Y-SD01Y))	°
SD_ANG2	Shoulders-Pelvis	ARCTAN((SD04X-SD07X)/(SD07Y-SD04Y))	°

Code	Related body parts	Formula	Units
SD_ANG3	Pelvis-Hips	ARCTAN((SD07X-SD09X)/(SD09Y-SD07Y))	°
SD_ANG4	Hips-Knees	ARCTAN((SD10X-SD09X)/(SD09Y-SD10Y))	°
SD_ANG5	Knees-Ankles	ARCTAN((SD11X-SD10X)/(SD10Y-SD11Y))	°
SD_DIST1	Head	SD01X-SD11X	mm
SD_DIST2	Shoulders	SD04X-SD11X	mm
SD_DIST3	Pelvis	SD07X-SD11X	mm
SD_DIST4	Hips	SD09X-SD11X	mm
SD_DIST5	Knees	SD10X-SD11X	mm

Deviations from horizontal and vertical alignment, moments of force and reaction forces, and center of gravity are calculated from the biomechanical parameters obtained from the images in the lateral, anterior and posterior views. The deviation values are referenced with respect to body alignment position values. These values are used both in the detection of postural deviations and also as a follow-up tool to assess patient progress after following a corrective exercise plan.

These values are used as a diagnostic tool and as a way to measure progress in the patient's condition.

Constants:

Head Ratio: RaH = 8.4%

Trunk Ratio: RaT = 58.4%

Gravity: G = 9.8 m/s^2

Global:

Weight Total: We = Total person mass (kg)

Weight head: $WeH = We * RaH * G$

Weight trunk: $WeT = We * RaT * G$

Weight head&trunk: $WeHT = WeH + WeT$

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Lateral Plane:

Angle Head: $LAnHA = ATan\left(\frac{SD01X - SD04X}{SD04Y - SD01Y}\right)$

Moment Head: $LMoH = \frac{WeH * (SD01X - SD04X)}{1000}$

Reaction Head: $L\,\mathrm{Re}\,H = -LMoH * 25 - WeH$

Reaction Head %: $Abs\left(\frac{L\,\mathrm{Re}\,H}{WeH}\right)$

Angle Trunk: $LAnTI = ATan\left(\frac{SD04X - SD07X}{SD07Y - SD04Y}\right)$

Moment Trunk: $LMoT = \frac{WeT * (SD04X - SD07X)}{1000}$

Reaction Trunk: $L\,\mathrm{Re}\,T = -LMoT * 20 - WeHT$

Reaction Trunk %: $L\,\mathrm{Re}\,TP = Abs\left(\frac{L\,\mathrm{Re}\,T}{WeT}\right)$

Angle Head&Trunk: $LAnHA = ATan\left(\frac{SD01X - SD07X}{SD07Y - SD01Y}\right)$

Moment Head&Trunk: $LMoHT = \frac{WeHT * (SD01X - SD07X)}{1000}$

Reaction Head&Trunk: $L\,\mathrm{Re}\,H = -LMoHT * 20 - WeHT$

Reaction Head&Trunk %: $L\,\mathrm{Re}\,HTP = Abs\left(\frac{L\,\mathrm{Re}\,HT}{WeHT}\right)$

Front Plane:

Angle Head: $LAnHA = ATan\left(\frac{FA02X - FA06X}{FA06Y - FA02Y}\right)$

Moment Head: $LMoH = \frac{WeH * (FA06X - FA02X)}{1000}$

Reaction Head: $L\,\mathrm{Re}\,H = -LMoH * 25 - WeH$

Reaction Head %: $Abs\left(\frac{LReH}{WeH}\right)$

Angle Trunk: $LAnTI = ATan\left(\frac{FA06X - FA10X}{FA10Y - FA06Y}\right)$

Moment Trunk: $LMoT = \frac{WeH * (FA10X - FA06)}{1000}$

Reaction Trunk: $LReT = -LMoT * 20 - WeT$

Reaction Trunk %: $LReTP = Abs\left(\frac{LReT}{WeT}\right)$

Angle Head and Trunk: $LAnHTI = ATan\left(\frac{FA02X - FA10X}{FA10Y - FA02Y}\right)$

Moment Head and Trunk: $LMoHT = \frac{WeHT * (FA10X - FA02X)}{1000}$

Reaction Head and Trunk: $LReHT = -LMoHT * 20 - WeHT$

Reaction Head and Trunk %: $Abs\left(\frac{LReHT}{WeHT}\right)$

The center of gravity projection is calculated as follows:

X coordinates: ((FA17X-(FA02X+FA04X)/2)*WeFAH+(FA17X-(FA07X+FA05X)/2)*WeFAS+(FA17X-(FA11X+FA09X)/2)*WeFAP+(FA17X-(FA14X+FA15X)/2)*WeFAK)/(WeFAH+WeFAS+WeFAP+WeFAK)

Y coordinates: ((SD11X-SD01X)*WeSDH+(SD11X-SD04X)*WESDS+(SD11X-SD07X)*WeSDP+(SD09X-SD10X)/SQRT((SD10Y-SD09Y)^2+(SD09X-SD10X)^2)*RATIO_SD_THIGH_LENGTH*Height*WeSDT+(SD10X-SD11X)/ SQRT((SD11Y-SD10Y)^2+(SD10X-SD11X)^2)*RATIO_SD_LEG_LENGTH*Height*WeSDK)/(WeSDH+WeSDS+WeSDP+WeSDT+WeSDK)

Where the parameters used to calculate the center of gravity are described herewith:

Parameters	Description	View

Parameters	Description	View
WeFAH	Head weight	Anterior
WeFAS	Shoulder weight	Anterior
WeFAP	Pelvis weight	Anterior
WeFAK	Segment weight (whole leg)	Anterior
WeSDH	Head weight	Lateral
WeSDS	Shoulder weight	Lateral
WeSDP	Pelvis weight	Lateral
WeSDT	Thigh weight	Lateral
WeSDK	Segment weight (knee to foot)	Lateral
Ratio_SD_Thigh_Length	Center of mass for the thigh in % of the segment length	Lateral
Ratio_SD_Leg_ Length	Center of mass for the leg (knee to foot) in % of the segment length	Lateral

These coordinates are then compared to the ideal center of gravity position located on the base of support between the feet.

When the Biomechanical Assessment is complete (a virtual instantaneous process through the central server), data are transferred back to the health-care practitioner's computer via the Web. A Biomechanical Assessment Report can then be generated and modified as needed. The health-care practitioner has the possibility to adjust postural deviations based on supplemental information that he or she may have noted during the patient's examination. Postural deviations are ranked automatically and based on the relative importance of the trunk and head and neck stability on postural function. The top three deviations are selected by default for the treatment, but the health-care practitioner has the possibility to select other deviations. Every change made by the health-care practitioner is identified in the system to take it into account during further statistical analysis. When the deviations selected for the treatment are

confirmed correctives exercises are automatically generated. A ten-week exercise schedule is generated which is, again, modifiable by the health-care practitioner if necessary. Exercises are selected compatible with a patient's activity level from low, to moderately to highly active. The health-care practitioner also has the opportunity to change exercise selection and/or schedule. The health-care practitioner can ask the system to increase or decrease the difficulty level of the program and generate a new schedule based on the request. The health-care practitioner can also remove or add exercises from the program because he or she thinks that a particular exercise can be harmful to the patient or to place emphasis on a particular deviation correction. Finally, health-care practitioner can reorganize the schedule in changing the order of exercises. Presented in Tables 2 and 3 are lists of deviations that are detectable by the current system, as well as the corrective actions by exercising and stretching to correct these deviations.

Table 2

Deviations - Exercises link

Deviations	*Actions*	*Exercises*		*Levels*
DIS001	Translation of the head to the left			
	NHLF_L.S			
		NHFLRO19SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL01 1SR	Neck lateral flexor stretch	*
		NHLO17SR	Assisted neck lateral flexor stretch	2,3
		NHLO24SR	Supine neck lateral flexor stretch	1
		NHLRO14SL	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SR	Neck extensor, lateral flexor and rotator stretch	1
		NHLRO18SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHXL005SR	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SR	Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
	NHLF_R.C			
		NHLF010CR	Cervical strengthening	1,2
		NHLF011CR	Supine cervical strengthening	1
		NHLF012CR	Cervical strengthening with elastic resistance	2,3
DIS002	Translation of the head to the right			
	NHLF_L.C			
		NHLF010CL	Cervical strengthening	1,2
		NHLF01 1CL	Supine cervical strengthening	1
		NHLF012CL	Cervical strengthening with elastic resistance	2,3
	NHLF_R.S			
		NHFLRO19SL	Assisted neck extensor, lateral flexor and rotator	2,3

Deviations	*Actions*	*Exercises*		*Levels*
			stretch	
		NHL01 1SL	Neck lateral flexor stretch	*
		NHLO17SL	Assisted neck lateral flexor stretch	2,3
		NHLO24SL	Supine neck lateral flexor stretch	1
		NHLRO14SR	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SL	Neck extensor, lateral flexor and rotator stretch	1

Deviations	*Actions*	*Exercises*		*Levels*
		NHLR018SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SL	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHLR021SL	Neck lateral flexor stretch	2,3
		NHXL005SL	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLR003SL	Neck flexor, rotator and lateral flexor stretch	1
		NHXLR007SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLR008SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
DIS003	Protrusion of the head			
	NHEX.S			
		NHF009SB	Neck extensor stretch	*
	NHFL.C			
		NHFL001CB	Cervical strengthening	2
		NHFLO02CB	Cervical strengthening	*
		NHFLO03CB	Supine cervical strengthening	2
		NHFLO09CB	Cervical strengthening	2
	TRCE.C			
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
DIS004	Posterior deviation of the head			
	NHEX.S			
		NHF009SB	Neck extensor stretch	*
	NHFL.C			
		NHFL001CB	Cervical strengthening	2
		NHFLO02CB	Cervical strengthening	*
		NHFLO03CB	Supine cervical strengthening	2
		NHFLO09CB	Cervical strengthening	2

Deviations	*Actions*	*Exercises*		*Levels*
	NHFL.S			
		NHEX001SB	Neck flexor stretch	1
		NHXLRO04SB	Assisted neck flexor stretch	2,3
	TRCE.S			
		TREX004SB	Standing torso flexion with arms reaching down	*

Deviations	*Actions*	*Exercises*		*Levels*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS005	Flexion of the head			
	NHEX.C			
		NHEX004CB	Cervical strengthening	1
		NHEX005CB	Cervical strengthening	1
		NHEX007CB	Cervical strengthening with elastic resistance	2,3
		NHEX008CB	Prone cervical strengthening	2
	NHLF_L.S			
		NHFLRO19SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL01 1SR	Neck lateral flexor stretch	*
		NHLO17SR	Assisted neck lateral flexor stretch	2,3
		NHLO24SR	Supine neck lateral flexor stretch	1
		NHLR014SL	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SR	Neck extensor, lateral flexor and rotator stretch	1
		NHLR01 8SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHXL005SR	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SR	Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
	NHLF_R.S			
		NHFLRO19SL	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL011SL	Neck lateral flexor stretch	*
		NHLO17SL	Assisted neck lateral flexor stretch	2,3
		NHLO24SL	Supine neck lateral flexor stretch	1
		NHLRO14SR	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SL	Neck extensor, lateral flexor and rotator stretch	1

Deviations	*Actions*	*Exercises*		*Levels*
		NHLR018SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SL	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHLR021SL	Neck lateral flexor stretch	2,3
		NHXL005SL	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLR003SL	Neck flexor, rotator and lateral flexor stretch	1
		NHXLR007SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		NHXLRO08SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
	TRCE.C			
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
DIS006	Extension of the head			
	NHEX.S			
		NHF009SB	Neck extensor stretch	*
	NHFL.C			
		NHFL001CB	Cervical strengthening	2
		NHFLO02CB	Cervical strengthening	*
		NHFLO03CB	Supine cervical strengthening	2
		NHFLO09CB	Cervical strengthening	2
	SCAD.S			
		SCAD001SB	Scapula adductor stretch with your hands behind your back	*
		SCAD007SB	Scapula adductor stretch with your arms crossed	1
DIS009	Lateral flexion of the head to the right			
	NHLF_L.C			
		NHLF010CL	Cervical strengthening	1,2
		NHLF01 1CL	Supine cervical strengthening	1
		NHLF012CL	Cervical strengthening with elastic resistance	2,3
	NHLF_R.S			
		NHFLRO19SL	Assisted neck extensor, lateral flexor and rotator stretch	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		NHL01 1SL	Neck lateral flexor stretch	*
		NHLO17SL	Assisted neck lateral flexor stretch	2,3
		NHLO24SL	Supine neck lateral flexor stretch	1
		NHLRO14SR	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SL	Neck extensor, lateral flexor and rotator stretch	1
		NHLRO18SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLRO20SL	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHLRO21SL	Neck lateral flexor stretch	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		NHXL005SL	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLR003SL	Neck flexor, rotator and lateral flexor stretch	1
		NHXLR007SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLR008SL	Assisted neck flexor, lateral flexor and rotator stretch	2,3
DIS010	Lateral flexion of the head to the left *NHLF_L.S*			
		NHFLR019SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL01 1SR	Neck lateral flexor stretch	*
		NHLO17SR	Assisted neck lateral flexor stretch	2,3
		NHLO24SR	Supine neck lateral flexor stretch	1
		NHLR014SL	Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SR	Neck extensor, lateral flexor and rotator stretch	1
		NHLRO18SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SR	Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHXL005SR	Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SR	Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SR	Assisted neck flexor, lateral flexor and rotator stretch	2,3
	NHLF_R.C			
		NHLF010CR	Cervical strengthening	1,2
		NHLF01 1CR	Supine cervical strengthening	1
		NHLF012CR	Cervical strengthening with elastic resistance	2,3
DIS011	Lateral translation the left *TRLF_L.C*	of the trunk to		
		TRFLO15CL	Isometric abdominal contraction with leg extension	1
		TRLF001CL	Lateral flexion with a dumbbell	2,3
		TRLF002CL	Lateral flexion with a dumbbell	2,3
		TRLF003CL	Lateral flexion with a bar	2,3
		TRLF004CL	Lateral flexion with a bar	1

Deviations	*Actions*	*Exercises*		*Levels*
		TRLF005CL	Lateral flexion with elastic resistance	*
		TRLF008CL	Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL	Inclined lateral flexion with crossed arms, holding a weight	3

Deviations	*Actions*	*Exercises*		*Levels*
	TRLF_R.S			
		TRLF001SR	Standing lateral trunk flexor stretch	*
	TRTE_R.S			
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS012	Lateral translation of the trunk to the right			
	TRLF_L.S			
		TRLF001SL	Standing lateral trunk flexor stretch	*
	TRLF_R.C			
		TRFLO15CR	Isometric abdominal contraction with leg extension	1
		TRLF001 CR	Lateral flexion with a dumbbell	2,3
		TRLF002CR	Lateral flexion with a dumbbell	2,3
		TRLF003CR	Lateral flexion with a bar	2,3
		TRLF004CR	Lateral flexion with a bar	1
		TRLF005CR	Lateral flexion with elastic resistance	*
		TRLF008CR	Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CR	Inclined lateral flexion with crossed arms, holding a weight	3
	TRTE_L.S			
		TREX001SB	Cat stretch	*
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS013	Anterior deviation			

Deviations	*Actions*	*Exercises*		*Levels*
	HIEX.S			
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
	HIFL_L.S			
		HIFLO01SL	Standing hip flexor stretch	2,3
		HIFLO02SL	Standing hip flexor stretch (partial)	1
		HIFLO03SL	Standing hip flexor stretch with back leg elevated	3
	HIFL_R.S			
		HIFLO01SR	Standing hip flexor stretch	2,3
		HIFLO02SR	Standing hip flexor stretch (partial)	1

Deviations	*Actions*	*Exercises*		*Levels*
		HIFLO03SR	Standing hip flexor stretch with back leg elevated	3
	SCAD.C			
		SCAD001 CB	Shoulder shrugs with dumbbells held in semi-supination while inclined	3
		SCAD002CB	Shoulder shrugs with dumbbells held in pronation while inclined	3
		SCAD003CB	Seated scapular adduction	*
	SHAD.S			
		SHAD001 SB	Shoulder adductor stretch	*
	TRLE.C			
		TREX001 CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
DIS014	Posterior deviation			
	HIFL_L.S			
		HIFLO01SL	Standing hip flexor stretch	2,3
		HIFLO02SL	Standing hip flexor stretch (partial)	1
		HIFLO03SL	Standing hip flexor stretch with back leg elevated	3
	HIFL_R.S			
		HIFLO01SR	Standing hip flexor stretch	2,3
		HIFLO02SR	Standing hip flexor stretch (partial)	1
		HIFLO03SR	Standing hip flexor stretch with back leg elevated	3
	SCAD.S			
		SCAD001 SIB	Scapula adductor stretch with your hands behind your back	*
		SCAD007SB	Scapula adductor stretch with your arms crossed	1

Deviations	*Actions*	*Exercises*		*Levels*
	TRFL.C			
		TRFL001CB	Abdominal crunch with feet elevated	1
		TRFL002CB	Abdominal crunch with feet on the ground	1
		TRFL003CB	Abdominal crunch with feet on the ground and lumbar support	1
		TRFL004CB	Abdominal crunch with arms crossed and feet elevated	1,2
		TRFL005CB	Abdominal crunch with hands behind the head and feet elevated	2

Deviations	*Actions*	*Exercises*		*Levels*
		TRFLO06CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO07CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO08CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO09CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO12CB	Hip raises (lower abdominal crunch)	3
		TRFLO13CB	Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFLO14CB	Isometric abdominal contraction	1
	TRLE.S			
		TREX001 SB	Cat stretch	*
		TREX002SB	Supine, knees to chest	1,2
		TREX003SB	Standing torso flexion	1,2
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX006SB	Seated trunk flexion	1
		TREX008SB	Seated full forward stretch	1,2
	TRTE.S			
		TREX001 SB	Cat stretch	*
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS015	Trunk flexion			
	HIEX.S			
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
	HIFL_L.S			
		HIFLO01SL	Standing hip flexor stretch	2,3
		HIFLO02SL	Standing hip flexor stretch (partial)	1

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Deviations	*Actions*	*Exercises*		*Levels*
		HIFL003SL	Standing hip flexor stretch with back leg elevated	3
	HIFL_RS			
		HIFL001SR	Standing hip flexor stretch	2,3
		HIFL002SR	Standing hip flexor stretch (partial)	1
		HIFL003SR	Standing hip flexor stretch with back leg elevated	3
	NHEX.S			
		NHF009SB	Neck extensor stretch	*

Deviations	*Actions*	*Exercises*		*Levels*
	SHAD.S			
		SHAD001SB	Shoulder adductor stretch	*
	TRLE.C			
		TREX001CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
	TRTE.C			
		TREX001 CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
DIS016	Trunk extension			
	NHEX_L .S			
		NHF009SB	Neck extensor stretch	*
		NHFR010SL	Assisted neck extensor, lateral flexor and rotator stretch	*
	NHEX_R .S			
		NHF009SB	Neck extensor stretch	*
		NHFRO10SR	Assisted neck extensor, lateral flexor and rotator stretch	*
	SCAB.C			
		SCAB001CB	Abdominal crunch with hands behind the head and feet on the floor	*
	SCAD.S			

Deviations	*Actions*	*Exercises*		*Levels*
		SCAD001SB	Scapula adductor stretch with your hands behind your back	*
		SCAD007SB	Scapula adductor stretch with your arms crossed	1
	TRLF_L.S			
		TRLF001SL	Standing lateral trunk flexor stretch	*
	TRLF_R.S			
		TRLF001 SR	Standing lateral trunk flexor stretch	*

Deviations	*Actions*	*Exercises*		*Levels*
	TRTE.S			
		TREX001SB	Cat stretch	*
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS019	Lateral flexion of the trunk to the right			
	TRLF_L.C			
		TRFLO15CL	Isometric abdominal contraction with leg extension	1
		TRLF001CL	Lateral flexion with a dumbbell	2,3
		TRLF002CL	Lateral flexion with a dumbbell	2,3
		TRLF003CL	Lateral flexion with a bar	2,3
		TRLF004CL	Lateral flexion with a bar	1
		TRLF005CL	Lateral flexion with elastic resistance	*
		TRLF008CL	Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL	Inclined lateral flexion with crossed arms, holding a weight	3
	TRLF_R.S			
		TRLF001 SR	Standing lateral trunk flexor stretch	*
DIS020	Lateral flexion of the trunk to the left			
	TRLF_L.S			
		TRLF001SL	Standing lateral trunk flexor stretch	*
	TRLF_R.C			
		TRFLO15CR	Isometric abdominal contraction with leg extension	1
		TRLF001 CR	Lateral flexion with a dumbbell	2,3
		TRLF002CR	Lateral flexion with a dumbbell	2,3
		TRLF003CR	Lateral flexion with a bar	2,3
		TRLF004CR	Lateral flexion with a bar	1
		TRLF005CR	Lateral flexion with elastic resistance	
		TRLF008CR	Lateral flexion on an incline bench with arms across	1,2

Deviations	*Actions*	*Exercises*		*Levels*
			the chest	
		TRLF009CR	Inclined lateral flexion with crossed arms, holding a weight	3
DIS021	Translation of the hip to the left			
	HIAB_L.C			
		HIABO01CL	Side lying hip abductor contraction	1

Deviations	*Actions*	*Exercises*		*Levels*
		HIABO02CL	Side lying hip abductor contraction	1
		HIABO03CB	Bilateral hip abductor contraction	2,3
		HIABO04CL	Unilateral hip abduction exercise	1,2
		HIABO05CL	Supine, anterior, unilateral hip abduction exercise with an elastic	2,3
		HIABO06CL	Side lying hip abductor contraction with dumbbells	2,3
		HIABO07CL	Side lying hip abductor contraction with elastic resistance	2,3
		HIABO08CL	Side lying hip abductor contraction with added weight	*
		HIAB011 CL	Standing unilateral hip abduction exercise	2,3
		HIABO12CL	Standing, anterior, unilateral hip abduction exercise	2,3
		HIABO13CL	Standing, posterior, unilateral hip abduction exercise	2,3
	HIAB_ R.S			
		HIABO01SR	Side lying hip abductor stretch	1,2,3
		HIABO05SR	Standing hip abductor stretch	2,3
		HIABO06SR	Standing hip abductor stretch with lateral flexion	2,3
		HIABO07SR	Standing hip abductor stretch with lateral flexion	*
	HIAD_ L.S			
		HIAD005SL	Standing hip adductor stretch	*
		HIAD008SL	Kneeling hip adductor stretch	3
	HIAD_ R.C			
		HIAD001CR	Side lying isometric hip adduction	*
		HIAD002CR	Supine hip adduction with elastic resistance	2,3
		HIAD003CR	Side lying hip adduction	2,3
		HIAD006CB	Supine hip adduction with a ball between the knees	1,2
		HIAD010CB	Supine hip adduction with a ball between the knees	1,2
		HIAD011CR	Side lying hip adduction with a ball placed between your feet	1,2
		HIAD012CR	Side lying hip adduction with a ball between the knees and thighs	1,2

Deviations	*Actions*	*Exercises*		*Levels*
DIS022	Translation of the	hip to the right		
	HIAB_ L.S			
		HIABO01SL	Side lying hip abductor stretch	1,2,3
		HIABO05SL	Standing hip abductor stretch	2,3
		HIABO06SL	Standing hip abductor stretch with lateral flexion	2,3
		HIABO07SL	Standing hip abductor stretch with lateral flexion	*
	HIAB_ R.C			

Deviations Actions	*Exercises*		*Levels*
	HIABO01CR	Side lying hip abductor contraction	1
	HIABO02CR	Side lying hip abductor contraction	*
	HIABO03CB	Bilateral hip abductor contraction	2,3
	HIABO04CR	Unilateral hip abductor exercise	1,2
	HIABO05CR	Supine, anterior, unilateral hip abduction exercise with an elastic	2,3
	HIABO06CR	Side lying hip abductor contraction with dumbbells	2,3
	HIABO07CR	Side lying hip abductor contraction with elastic resistance	2,3
	HIABO08CR	Side lying hip abductor contraction with added weight	3
	HIAB011 CR	Standing unilateral hip abduction exercise	2,3
	HIABO12CR	Standing, anterior, unilateral hip abduction exercise	2,3
	HIABO13CR	Standing, posterior, unilateral hip abduction exercise	2,3
HIAD_L.C			
	HIAD001CL	Side lying isometric hip adduction	1
	HIAD002CL	Supine hip adduction with elastic resistance	2,3
	HIAD003CL	Side lying hip adduction	2,3
	HIAD006CB	Supine hip adduction with a ball between the knees	1,2
	HIAD010CB	Supine hip adduction with a ball between the knees	1,2
	HIAD011CL	Side lying hip adduction with a ball placed between your feet	1,2
	HIAD012CL	Side lying hip adduction with a ball between the knees and thighs	1,2
HIAD_R.S			
	HIAD005SR	Standing hip adductor stretch	*
	HIAD008SR	Kneeling hip adductor stretch	3
DIS023 Anterior translation of the hip			
HIEX.C			
	HIEX001CB	Supine pelvic tilt	*
HIFL_L.S			
	HIFLO01SL	Standing hip flexor stretch	2,3
	HIFLO02SL	Standing hip flexor stretch (partial)	1

Deviations Actions	*Exercises*		*Levels*
	HIFLO03SL	Standing hip flexor stretch with back leg elevated	3
HIFL_RS			
	HIFLO01SR	Standing hip flexor stretch	2,3
	HIFLO02SR	Standing hip flexor stretch (partial)	1
	HIFLO03SR	Standing hip flexor stretch with back leg elevated	3

Deviations	*Actions*	*Exercises*		*Levels*
DIS024	Posterior translation of the hip			
	HIEX_L.S			
		HIEX001SL	Standing hamstring stretch	*
		HIEX002SL	Supine hamstring stretch	2,3
		HIEX003SL	Supine hamstring stretch	1
		HIEX004SL	Supine hamstring stretch	1
		HIEX007SL	Supine hamstring stretch	1
		HIEX008SL	Supine hamstring stretch	2,3
		HIEX011SL	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
		HIEX014SL	Standing hamstring stretch	2,3
	HIEX_R.S			
		HIEX001SR	Standing hamstring stretch	*
		HIEX002SR	Supine hamstring stretch	2,3
		HIEX003SR	Supine hamstring stretch	1
		HIEX004SR	Supine hamstring stretch	1
		HIEX007SR	Supine hamstring stretch	1
		HIEX008SR	Supine hamstring stretch	2,3
		HIEX01 1SR	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
		HIEX014SR	Standing hamstring stretch	2,3
	HIFL_L.C			
		HIFL001CB	Squat	*
		HIFL002CB	Unilateral squat	*
		TRFL010CL	Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CL	Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFL012CB	Hip raises (lower abdominal crunch)	3
	HIFL_R.C			

Deviations	*Actions*	*Exercises*		*Levels*
		HIFL001CB	Squat	*
		HIFLO02CB	Unilateral squat	*
		TRFL010CR	Abdominal crunch with unilateral hip flexion	2,3
		TRFLO11CR	Abdominal crunch with arms overhead and feet elevated	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		TRFLO12CB	Hip raises (lower abdominal crunch)	3
DIS025	Anterior pelvic tilt			
	HIEX.C			
		HIEX001CB	Supine pelvic tilt	*
	HIEX_L.S			
		HIEX001SL	Standing hamstring stretch	*
		HIEX002SL	Supine hamstring stretch	2,3
		HIEX003SL	Supine hamstring stretch	1
		HIEX004SL	Supine hamstring stretch	1
		HIEX007SL	Supine hamstring stretch	1
		HIEX008SL	Supine hamstring stretch	2,3
		HIEX01 1SL	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
		HIEX014SL	Standing hamstring stretch	2,3
	HIEX_R.S			
		HIEX001SR	Standing hamstring stretch	*
		HIEX002SR	Supine hamstring stretch	2,3
		HIEX003SR	Supine hamstring stretch	1
		HIEX004SR	Supine hamstring stretch	1
		HIEX007SR	Supine hamstring stretch	1
		HIEX008SR	Supine hamstring stretch	2,3
		HIEX01 1SR	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
		HIEX014SR	Standing hamstring stretch	2,3
	HIFL_L.S			
		HIFLO01SL	Standing hip flexor stretch	2,3
		HIFLO02SL	Standing hip flexor stretch (partial)	1
		HIFLO03SL	Standing hip flexor stretch with back leg elevated	3

HIFL_R.S

HIFLO01SR	Standing hip flexor stretch	2,3
HIFLO02SR	Standing hip flexor stretch (partial)	1
HIFLO03SR	Standing hip flexor stretch with back leg elevated	3

TRFL.C

Deviations	*Actions*	*Exercises*		*Levels*
		TRFL001CB	Abdominal crunch with feet elevated	1
		TRFL002CB	Abdominal crunch with feet on the ground	1
		TRFL003CB	Abdominal crunch with feet on the ground and lumbar support	1
		TRFL004CB	Abdominal crunch with arms crossed and feet elevated	1,2
		TRFL005CB	Abdominal crunch with hands behind the head and feet elevated	2
		TRFL006CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFL007CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFL008CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL009CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL012CB	Hip raises (lower abdominal crunch)	3
		TRFL013CB	Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFL014CB	Isometric abdominal contraction	1
	TRLE.S			
		TREX001 SB	Cat stretch	*
		TREX002SB	Supine, knees to chest	1,2
		TREX003SB	Standing torso flexion	1,2
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX006SB	Seated trunk flexion	1
		TREX008SB	Seated full forward stretch	1,2
DIS026	Posterior pelvic tilt			
	HIEX_L.S			
		HIEX001SL	Standing hamstring stretch	*
		HIEX002SL	Supine hamstring stretch	2,3
		HIEX003SL	Supine hamstring stretch	1

HIEX004SL	Supine hamstring stretch	1
HIEX007SL	Supine hamstring stretch	1
HIEX008SL	Supine hamstring stretch	2,3
HIEX011SL	Seated hamstring stretch	2,3
HIEX012SB	Seated bilateral hamstring stretch	*
HIEX013SB	Seated bilateral hamstring stretch	3
HIEX014SL	Standing hamstring stretch	2,3

HIEX_RS

Deviations	*Actions*	*Exercises*		*Levels*
		HIEX001SR	Standing hamstring stretch	*
		HIEX002SR	Supine hamstring stretch	2,3
		HIEX003SR	Supine hamstring stretch	1
		HIEX004SR	Supine hamstring stretch	1
		HIEX007SR	Supine hamstring stretch	1
		HIEX008SR	Supine hamstring stretch	2,3
		HIEX01 1SR	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch	*
		HIEX013SB	Seated bilateral hamstring stretch	3
		HIEX014SR	Standing hamstring stretch	2,3
	HIFL_L.C			
		HIFL001CB	Squat	*
		HIFL002CB	Unilateral squat	*
		TRFL010CL	Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CL	Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFL012CB	Hip raises (lower abdominal crunch)	3
	HIFL_R.C			
		HIFL001CB	Squat	*
		HIFL002CB	Unilateral squat	*
		TRFL010CR	Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CR	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL012CB	Hip raises (lower abdominal crunch)	3
	TRFL.S			
		TRFL001SB	Cobra	*
	TRLE.C			
		TREX001CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		TREX012CB	Seated lumbar extension	1
DIS029	Lateral elevation of the hip to the left			
	TRFL.S			
		TRFL001	Cobra	
		SIB		

Deviations	*Actions*	*Exercises*		*Levels*
	TRLE.C			
		TREX001CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
	TRLF_L.S			
		TRLF001 SL	Standing lateral trunk flexor stretch	*
	TRLF_R.C			
		TRFLO15CR	Isometric abdominal contraction with leg extension	1
		TRLF001CR	Lateral flexion with a dumbbell	2,3
		TRLF002CR	Lateral flexion with a dumbbell	2,3
		TRLF003CR	Lateral flexion with a bar	2,3
		TRLF004CR	Lateral flexion with a bar	1
		TRLF005CR	Lateral flexion with elastic resistance	*
		TRLF008CR	Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CR	Inclined lateral flexion with crossed arms, holding a weight	3
	TRTE.C			
		TREX001CB	Kneeling trunk extension	2,3
		TREX002CB	Prone trunk extension	2,3
		TREX007CB	Arm and hip extension	2,3
		TREX010CB	Prone lumbar extension with hands on the lower back	*
		TREX011CB	Prone lumbar extension with hands behind your head	2,3
		TREX012CB	Seated lumbar extension	1
DIS030	Lateral elevation of the hip to			

Deviations	*Actions*	*Exercises*		*Levels*
	the right			
	TRFL.C			
		TRFL001CB	Abdominal crunch with feet elevated	1
		TRFL002CB	Abdominal crunch with feet on the ground	1
		TRFL003CB	Abdominal crunch with feet on the ground and lumbar support	1
		TRFL004CB	Abdominal crunch with arms crossed and feet elevated	1,2
		TRFL005CB	Abdominal crunch with hands behind the head and feet elevated	2

Deviations	*Actions*	*Exercises*		*Levels*
		TRFLO06CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO07CB	Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFL008CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO09CB	Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO12CB	Hip raises (lower abdominal crunch)	3
		TRFLO13CB	Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFLO14CB	Isometric abdominal contraction	1
	TRLE.S			
		TREX001 SB	Cat stretch	*
		TREX002SB	Supine, knees to chest	1,2
		TREX003SB	Standing torso flexion	1,2
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX006SB	Seated trunk flexion	1
		TREX008SB	Seated full forward stretch	1,2
	TRLF_L.C			
		TRFLO15CL	Isometric abdominal contraction with leg extension	1
		TRLF001CL	Lateral flexion with a dumbbell	2,3
		TRLF002CL	Lateral flexion with a dumbbell	2,3
		TRLF003CL	Lateral flexion with a bar	2,3
		TRLF004CL	Lateral flexion with a bar	1
		TRLF005CL	Lateral flexion with elastic resistance	
		TRLF008CL	Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL	Inclined lateral flexion with crossed arms, holding a weight	3
	TRLF_R.S			

Deviations	Actions	Exercises		Levels
		TRLF001SR	Standing lateral trunk flexor stretch	*
	TRTE.S			
		TREX001 SB	Cat stretch	*
		TREX004SB	Standing torso flexion with arms reaching down	*
		TREX009SB	Supine back extensor stretch propped up on your elbows	1
DIS031	Plantar flexion of the right foot			
	ANDF_R.C			
		ANDF001 CB	Bilateral toe raises	2,3
		ANDF002CR	Ankle dorsiflexion with elastic resistance	1,2
	ANPF R.S			
		AN PF001 SR	Supine plantar flexor stretch	
		ANPF002SR	Supine plantar flexor stretch with a towel	2
		ANPF003SR	Standing plantar flexor stretch	1,2
		ANPF004SB	Standing bilateral plantar flexor stretch	2
DIS032	Dorsiflexion of the right foot			
	ANDF R:S			
		ANDF001 SR	Seated ankle dorsiflexor stretch	
	ANPF R.C			
		ANPF001 CR	Standing plantar flexor isometric contraction	3
		ANPF002CB	Bilateral isometric plantar flexor contraction with a ball	1

Deviations	*Actions*	*Exercises*		*Levels*
		ANPF004CB	Standing bilateral plantar flexor strengthening	1,2
		ANPF005CR	Standing plantar flexor strengthening	3
		ANPF006CR	Seated plantar flexor strengthening with elastic resistance	1,2
DIS033	Internal rotation of the right foot			
	ANEV R. C			
		ANEVC001 CR	Seated ankle eversion with elastic resistance	
	HIER R. C			
		HIER001 CR	Side lying hip abductor f external rotator exercise	
		HIER002CB	Seated bilateral hip abductor/external rotator exercise	
		HIER003CR	Side lying hip abductor/external rotator contractions with a dumbbell	
	HIEX L. S			
		HIEX001 SL	Standing hamstring stretch	
		HIEX002SL	Supine hamstring stretch	2,3
		HIEX003SL	Supine hamstring stretch	1
		HIEX004SL	Supine hamstring stretch	1
		HIEX007SL	Supine hamstring stretch	9
		HIEX008SL	Supine hamstring stretch	2,3
		HIEX011SL	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB	Seated bilateral hamstring stretch (legs together)	3
		HIEX014SL	Standing hamstring stretch	2,3
		HIEX015SL	Supine hamstring stretch	
	HIEX R. C			
		HIEX001 CB	Supine pelvic tilt	
		HIEX003CR	Supine pelvic tilt	2,3

Deviations	*Actions*	*Exercises*		*Levels*
		HIEX004CR	Supine pelvic tilt with one leg extended at the knee	3
		HIEX005CR	Kneeling hip extensor exercise (leg flexed at the knee)	2
		HIEX006CR	Kneeling hip extensor exercise (leg extended)	2,3
	HIFL L.S			
		HIFL001 SL	Standing hip flexor stretch	2,3
		HIFL002SL	Standing hip flexor stretch (partial)	1
		HIFL003SL	Standing hip flexor stretch with back leg elevated	3
	HIFL R. C			
		HIFL001CB	Squat	

Deviations	*Actions*	*Exercises*		*Levels*
		TRFLO10CR	Abdominal crunch with unilateral hip flexion	2,3
		I CR	Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFLO12CS	Hip raises (lower abdominal contraction)	3
DIS034	External rotation of the right foot			
	AKIN R. C			
		ANINCO01 CR	Seated ankle inversion with elastic resistance	
	HIER R.S			
		HIER002SR	Supine hip external rotator stretch	3
		HIER003SR	Supine hip external rotator stretch	I
		HIER004SR	Supine assisted hip external rotator stretch	1,2
		HIER005SR	Supine assisted hip external rotator stretch	3
		HIER006SR	Seated assisted hip external rotator stretch	1
		HIER009SR	Supine assisted hip external rotator stretch	2,3
		HIER012SR	Prone hip external rotator stretch	
	HIE X R. S			
		HIEX001SR	Standing hamstring stretch	
		HIEX002SR	Supine hamstring stretch	2,3
		HIEX003SR	Supine hamstring stretch	1
		HIEX004SR	Supine hamstring stretch	1
		HIEX007SR	Supine hamstring stretch	1
		HIEX008SR	Supine hamstring stretch	2,3
		HIEX011SR	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB	Seated bilateral hamstring stretch (legs together)	3
		HIEX014SR	Standing hamstring stretch	2,3
		HIEX015SR	Supine hamstring stretch	
	HIFL R.S			
		HIFIL001SR	Standing hip flexor stretch	2,3
		HIFLO02SR	Standing hip flexor stretch (partial)	1
		HIFLO03SR	Standing hip flexor stretch with back leg elevated	3

Deviations	*Actions*	*Exercises*		*Levels*
	HIIR R C			
		H11R001CR	Side lying isometric hip adduction and internal rotation	
		HIIR002CB	Supine knee-to-knee adduction and internal rotation	
		HIIR003CB	Supine hip adduction and internal rotation with a ball	TRFLDI

Deviations	*Actions*	*Exercises*		*Levels*
DIS037	Genu valgum right			
	HIAB R. S			
		HIAB001 SR	Side lying hip abductor stretch	1,2,3
		HIABO05SR	Standing hip abductor stretch	2,3
		HIABO06SR	Standing hip abductor stretch with lateral flexion	2,3
		HIABO07SR	Standing hip abductor stretch with lateral flexion	
	HIAD R. C			
		HIAD001 CR	Side lying isometric hip adduction	
		HIAD002CR	Supine hip adduction with elastic resistance	2,3
		HIAD003CR	Side lying hip adduction with elastic resistance	2,3
		HIAD006CB	Supine hip adduction with a ball between the knees	1,2
		HIAD010CB	Supine hip adduction with a ball between the knees	1,2
		HIAD011CR	Side lying hip adduction with a ball placed between your ankles	1,2
		HIAD012OR	Side lying hip adduction with a ball between the knees and thighs	1,2
DIS038	Genu valgum left			
	HIAB L. S			
		HIAB001 SL	Side lying hip abductor stretch	1,2,3
		HIABO05SL	Standing hip abductor stretch	2,3
		HIABO06SL	Standing hip abductor stretch with lateral flexion	2,3
		HIABO07SL	Standing hip abductor stretch with lateral flexion	

Deviations	*Actions*	*Exercises*		*Levels*
	HIAD L. C			
		HIAD001CL	Side lying isometric hip adduction	1
		HIAD002CL	Supine hip adduction with elastic resistance	2,3
		HIAD003CL	Side lying hip adduction with elastic resistance	2,3
		HIAD006CB	Supine hip adduction with a ball between the knees	1,2
		HIAD010CB	Supine hip adduction with a ball between the knees	1,2
		HIAD011CL	Side lying hip adduction with a ball placed between your ankles	1,2
		HIAD012CL	Side lying hip adduction with a ball between the knees and thighs	1,2
DIS039	Genu varum right			
	HIAB R. C			
		HIAB001CR	Side lying hip abductor contraction	1
		HIABO02CR	Side lying hip abductor contraction	

Deviations	*Actions*	*Exercises*		*Levels*
		HIABO03CB	Seated bilateral hip abduction with elastic resistance	2,3
		HIABO04CR	Side lying hip abduction exercise	1,2
		HIABO05CR	Supine hip abduction exercise with elastic resistance	2,3
		HIABO06CR	Side lying hip abductor exercise with dumbbells	2,3
		HIABO07CR	Side lying hip abductor contraction with elastic resistance	2,3
		HIABO08CR	Side lying hip abductor contraction with added weight	3
		HIABO11CR	Standing hip abduction exercise with elastic resistance	2,3
		HIABO12CR	Standing hip abduction exercise with elastic resistance	2,3
		HIAB013CR	*Standing hip* abduction exercise with elastic resistance	2,3
	HIADR.S			
		HIAD005SR	Standing hip adductor stretch	
		HIAD008SR	Kneeling hip adductor stretch	3
DIS040	Genu varum left			
	HIAB L. C			
		HIAB001CL	Side lying hip abductor contraction	1
		HIABO02CL	Side lying hip abductor contraction	1
		HIABO03CB	Seated bilateral hip abduction with elastic resistance	2,3
		HIABO04CL	Side lying hip abduction exercise	1,2
		HIABO05CL	Supine hip abduction exercise with elastic resistance	2,3
		HIABO06CL	Side lying hip abductor exercise with dumbbells	2,3
		HIABO07CL	Side lying hip abductor contraction with elastic resistance	2,3
		HIAB008CL	Side lying hip abductor contraction with added weight	
		HIABO11CL	Standing tip abduction exercise with elastic	2,3

Deviations	*Actions*	*Exercises*		*Levels*
			resistance	
		HIABO12CL	Standing hip abduction exercise with elastic resistance	2,3
		HIABO13CL	Standing hip abduction exercise with elastic resistance	2,3
	HIAD L.S			
		HIAD005SL	Standing hip adductor stretch	
		HIAD008SL	Kneeling hip adductor stretch	3
DIS041	Anterior deviation of the shoulders			
	SCAR C			

Deviations	*Actions*	*Exercises*		*Levels*
		SCAD001 CB	Shoulder shrugs with dumbbells held in semi-supination on an incline	3
		SCAD002CB	Shoulder shrugs with dumbbells held in pronation on an incline bench	3
		SCAD003CS	Seated scapula adductor exercise	
	SHFL.S			
		SHFLO05SB	Assisted shoulder flexor stretch	
	SHIR. S			
		SHIR006SR	Bent-over shoulder stretch	
DIS042	Posterior deviation of the shoulders			
	SCAB. C			
		SCAB001CB	Abdominal crunch with hands behind your head and feet on the floor	
	SCAD. S			
		SCAD001 SB	Scapula adductor stretch with both hands behind your back	
		SCAD007SB	Scapula adductor stretch with your arms crossed	1
	SHFL. C			
		SHFL001 CB	Standing bilateral shoulder flexor exercise with a ball	1,2
		SHFLO02CB	Standing bilateral shoulder flexor exercise with a ball	1,2
		SHFLO03CB	Shoulder flexor exercise with elastic resistance	1,2
		SHFLO05CB	Forward shoulder flexion with 3 elastics	2,3
		SHFLO06CB	Standing shoulder forward flexion with dumbbells	3
		SHFLO07CB	Standing shoulder forward flexion and rotation with dumbbells	3
	SHIR. C			
		SHABO03CB	Bilateral shoulder abduction with dumbbells (palms backward)	3
		SHIR002CB	Prone shoulder internal rotator exercise with bar and elastics	
DIS043	External rotation of the left foot			

Deviations	*Actions*	*Exercises*		*Levels*
	ANIN L. C			
		ANINC001 CL	Seated ankle inversion with elastic resistance	
	HIER L. S			
		HIER002SL	Supine hip external rotator stretch	3
		HIER003SL	Supine hip external rotator stretch	1
		HIER004SL	Supine assisted hip external rotator stretch	1,2
		HIER005SL	Supine assisted hip external rotator stretch	3

Deviations	*Actions*	*Exercises*		*Levels*
		HIER006SL	Seated assisted hip external rotator stretch	1
		HIER009SL	Supine assisted hip external rotator stretch	2,3
		HIER012SL	Prone hip external rotator stretch	
	HIEX L. S			
		HIEX001SL	Standing hamstring stretch	
		HIEX002SL	Supine hamstring stretch	2,3
		HIEX003SL	Supine hamstring stretch	1
		HIEX004SL	Supine hamstring stretch	1
		HIEX007SL	Supine hamstring stretch	1
		HIEX008SL	Supine hamstring stretch	2,3
		HIEX011SL	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB	Seated bilateral hamstring stretch (legs together)	3
		HIEX014SL	Standing hamstring stretch	2,3
		HIEX015SL	Supine hamstring stretch	
	HIFL L. S			
		HIFLO01SL	Standing hip flexor stretch	2,3
		HIFLO02SL	Standing hip flexor stretch (partial)	1
		HIFLO03SL	Standing hip flexor stretch with back leg elevated	3
	HIIR L. C			
		HIIR001 CL	Side lying isometric hip adduction and internal rotation	
		HIIR002CB	Supine knee-to-knee adduction and internal rotation	
		HIIR003CB	Supine hip adduction and internal rotation with a ball	"
Internal rotation of the left foot				
	ANEV L. C			
		ANEVC001 CL	Seated ankle eversion with elastic resistance	
	HIER L. C			
		HIER001 CL	Side lying hip abductor / external rotator exercise	
		HIER002C B	Seated bilateral hip abductor/external rotator exercise	

Deviations	*Actions*	*Exercises*		*Levels*
		HI ER003CL	Side lying hip abductor/external rotator contractions with a dumbbell	
	HIEX L. C			
		HIEX001C B	Supine pelvic tilt	
		HIEX003C L	Supine pelvic tilt	2,3
		HIEX004C L	Supine pelvic tilt with one leg extended at the knee	3

Deviations	*Actions*	*Exercises*		*Levels*
		HIEX005CL	Kneeling hip extensor exercise (leg flexed at the knee)	2
		HIEX006CL	Kneeling hip extensor exercise (leg extended)	2,3
	HIEX R. S			
		HIEX001SR	Standing hamstring stretch	
		HIEX002SR	Supine hamstring stretch	2,3
		HIEX003SR	Supine hamstring stretch	1
		HIEX004SR	Supine hamstring stretch	1
		HIEX007SR	Supine hamstring stretch	1
		HIEX008SR	Supine hamstring stretch	2,3
		HIEX011SR	Seated hamstring stretch	2,3
		HIEX012SB	Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB	Seated bilateral hamstring stretch (legs together)	3
		HIEX014SR	Standing hamstring stretch	2,3
		HIEX015SR	Supine hamstring stretch	
	HIFL L. C			
		HIFL001CB	Squat	
		TRFLO10CL	Abdominal crunch with unilateral hip flexion	2,3
		TRFL01 1 CL	Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFLO12CB	Hip raises (lower abdominal contraction)	3
	HIFL R.S			
		HIFL001 SR	Standing hip flexor stretch	2,3
		HIFLO02SR	Standing hip flexor stretch (partial)	1
		HIFLO03SR	Standing tip flexor stretch with back leg elevated	3

Table 3

Body part	Action code	Description
Ankle (AN)	ANDL	Ankle dorsiflexion
	ANPF	Ankle plantar flexion
	ANIN	Ankle inversion
	ANEV	Ankle eversion
Elbow(EL)	ELFL	Elbow flexion
	ELEX	Elbow extension
	ELSU	Elbow supination (of forearm)
	ELPR	Elbow pronation (of forearm)
Hip (HI)	HIFL	Hip flexion
	HIEX	Hip extension
	HIAD	Hip adduction
	HIAB	Hip abduction
Knee (KN)	KNEX	Knee extension
	KNFL	Knee flexion
	KNIR	Knee internal rotation
	KNER	Knee external rotation
Neck Head (NH)	NHFL	Neck Head flexion
	NHEX	Neck Head extension
	NHFL	Neck Head lateral flexion
	NHIR	Neck Head ipsi-rotation
	NHCR	Neck Head contra-rotation
Scapula (SC)	SCEL	Scapula elevation
	SCDE	Scapula depression
	SCAB	Scapula abduction
	SCAD	Scapula adduction

Body part	Action code	Description
	SCER	Scapula external rotation
	SCIR	Scapula internal rotation
	SCAN	Scapula anterior inclination
Shoulder (SH)	SHAB	Shoulder abduction
	SHAD	Shoulder adduction
	SHER	Shoulder external rotation
	SHFL	Shoulder flexion
	SHIR	Shoulder internal rotation
	SHEX	Shoulder extension
Trunk (TR)	TRFL	Trunk flexion
	TRLF	Trunk lateral flexion
	TRLE	Trunk lumbar extension
	TRTE	Trunk thoracic extension
	TRCE	Trunk cervical extension
	TRRO	Trunk rotation
Wrist (WR)	WRFL	Wrist flexion
	WREX	Wrist extension
	WRAB	Wrist abduction
	WRAD	Wrist adduction

In a preferred embodiment of the present invention, the system generates a complete list of deviations for the client, in order of corrective priority. Priority is given to those deviations of body segments that are most perturbing to overall postural stability. Severity is also included in the decision making process, and only parameters exceeding critical values from correct vertical or horizontal alignment (of distance or angle) are considered deviations. These critical values were based on

consultations with clinicians treating postural disorders and form a preliminary identification of severity. One of the advantages of the current system is that we will have access to large numbers of normative data from which severity rankings can be revised, as necessary. The first three ranked deviations in order of priority are automatically included in the design of the client's exercise and stretching program. The remaining deviations may be manually selected by the health-care professional based on his or her clinical experience and familiarity with the patient.

Table 4 shows the priority factors given to postural deviations.

Table 4

Deviations

Code *DIS001*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Translation of the	Neck Head	50	50	NHLF_R.C,NHLF_L.S	(((FA02X + FA03X) / 2) >= FA06X + 10) AND (((FA02X + FA03X) / 2) < FA06X + 20) AND (ABS(FA02X - FA04X) < 10)
2	Translation of the	Neck Head	50	100	NHLF_R.C,NHLF_L.S	(((FA02X + FA03X) / 2) >= FA06X + 20) AND (ABS(FA02X - FA04X) < 10)

Code *DIS002*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Translation of the	Neck Head	50	50	NHLF_L.C,NHLF_R.S	(((FA02X + FA03X) / 2) <= FA06X - 10) AND (((FA02X + FA03X) / 2) > FA06X - 20) AND (ABS(FA02X - FA04X) < 10)
2	Translation of the	Neck Head	50	100	NHLF_L.C,NHLF_R.S	(((FA02X + FA03X) / 2) <= FA06X - 20) AND (ABS(FA02X - FA04X) < 10)

Code *DIS003*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*

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Deviations

Code DIS001

Level	Name	Group	Factor	Priority	Actions	Formula
1	Protrusion of the h	Neck Head	50	50	TRCE.C,NHEX.S,NHFL.C	(SD01X >= SD04X + 25) AND (SD01X < SD04X + 50)
2	Protrusion of the h	Neck Head	50	100	TRCE.C,NHEX.S,NHFL.C	(SD01X >= SD04X + 50)

Code DIS004

Level	Name	Group	Factor	Priority	Actions	Formula
1	Posterior deviation	Neck Head	50	50	TRCE.S,NHEX.S,NHFL.S,NHFL.C	(SD01X <= SD04X - 25) AND (SD01X > SD04X - 50)
2	Posterior deviation	Neck Head	50	100	TRCE.S,NHEX.S,NHFL.S,NHFL.C	(SD01X <= SD04X - 50)

Code *DIS005*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Flexion of the hea	Neck Head	50	50	TRCE.C,NHFL.C,NHEX.S	(SD02X >= SD03X + 20) AND (SD02X < SD03X + 35)
2	Flexion of the hea	Neck Head	50	100	TRCE.C,NHFL.C,NHEX.S	(SD02X >= SD03X + 35)

Code *DIS006*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Extension of the h	Neck Head	50	50	NHEX.C,NHFL.S,TRCE.C	(SD02X <= SD03X - 20) AND (SD02X > SD03X - 35)
2	Extension of the h	Neck Head	50	100	NHEX.C,NHFL.S,TRCE.C	(SD02X <= SD03X - 35)

Code *DIS009*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Lateral flexion of t	Neck Head	50	50	NHLF_L.C,NHLF_R.S	(FA02X <= FA 04X - 10) AND (FA02X > FA04X - 20)
2	Lateral flexion oft	Neck Head	50	100	NHLF_L.C,NHLF_R.S	(FA02X <= FA04X - 20)

Code *DIS010*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Lateral flexion of t	Neck Head	50	50	NHLF_R.C,NHLF_L.S	(FA02X >= FA04X + 10) AND (FA02X < FA04X + 20)

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2 Lateral flexion oft Neck Head 50 100 NHLF R.C,NHLF_L.S (FA02X >= FA04X + 20)

Code *DJSO11*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Lateral translation	Trunk	40	40	TRLF_L.C,TRLF_R.S,TRTE_R.S	(FA06 >= FA10 + 20) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 <= FP08 - 20) AND (ABS(FP04Y - FP05Y) < 25) AND (FA06 < FA10 + 40) AND (FP03 > FP08 - 40)
2	Lateral translation	Trunk	40	80	TRLF_L.C,TRLF_R.S,TRTE_R.S	(FA06 >= FA10 + 40) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 <= FP08 - 40) AND (ABS(FP04Y - FP05Y) < 25)

Code *DIS012*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Lateral translation	Trunk	40	40	TRLF_R.C,TRLF_L.S,TRTE_L.S	(FA06 <= FA10 - 20) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 >= FP08 + 20) AND (ABS(FP04Y- FP05Y) < 25) AND (FA06 > FA10 - 40) AND (FP03 < FP08 + 40)
2	Lateral translation	Trunk	40	80	TRLF_R.C,TRLF_L.S,TRTE_L.S	(FA06 <= FA10 - 40) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 >= FP08 + 40) AND (ABS(FP04Y - FP05Y) < 25)

Code *DIS013*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Anterior deviation	Trunk +	41	41	TRLE.C,HIFL_L.S,HIFL_R.S,HIEX.S, SHAD.S,SCAD.C	(SD04X >= SD07X + 20) AND (SD04X > SD07X + 40)
2	Anterior deviation	Trunk +	41	82	TRLE.C,HIFL_L.S,HIFL_R.S,HIEX.S SHAD.S,SCAD.C	(SD04X >= SD07X + 40)

Code *DIS014*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Posterior deviation	Trunk +	41	41	TRLE.S,TRTE.S,TRFL.C,SCAD.S,HI	(SD04X <= SD07X - 20) AND (SD04X > SD07X -

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							FL_L.S,HIFL_R.S	40)
2	Posterior deviation	Trunk +	41		82		TRLE.S,TRTE.S,TRFL.C,SCAD.S,HI	(SD04X <= SD07X - 40)
							FL_L.S,HIFL_R.S	
Code	*DIS015*							
	Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*		*Formula*
	1	Trunk flexion	Trunk	40	40	TRLE.C,TRTE.C,HIFL_L.S,HIFL_R.S,NHEX.S,HIEX.S,SHAD.S		FALSE

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Code DIS016

Level	Name	Group	Factor	Priority	Actions	Formula
1	Trunk extension	Trunk	40	40	TRLF_L.S,TRLF_R.S,TRTE.S,SCAD.S,SCAB.C,NHCX_L.S,NHEX_R.S	FALSE

Code DIS019

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral flexion oft	Trunk +	41	41	TRLF_L.C,TRLF_R.S	(FA05Y <= FA07Y - 25) AND (FP04Y >= FP05Y + 25) AND (FA06X <= FA10X - 25) AND (FP03X >= FP08X + 25) AND (FA05Y > FA07Y - 50) AND (FP04Y < FP05Y + 50) AND (FA06X > FA10X - 50) AND (FP03X < FP08X + 50)
2	Lateral flexion of t	Trunk +	41	82	TRLF_L.C,TRLF_R.S	(FA05Y <= FA07Y - 50) AND (FP04Y >= FP05Y + 50) AND (FA06X <= FA10X - 50) AND (FP03X >= FP08X + 50)

Code DIS020

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral flexion oft	Trunk +	41	41	TRLF_R.C,TRLF_L.S	(FA05Y >= FA07Y + 25) AND (FP04Y <= FP05Y - 25) AND (FA06X >= FA10X + 25) AND (FP03X <= FP08X - 25) AND (FA05Y < FA07Y +

						50) AND (FP04Y > FP05Y - 50) AND (FA06X <
						FA10X + 50) AND (FP03X > FP08X - 50)
2	Lateral flexion of t Trunk +	41	82	TRLF_R.C;TRLF_L.S		(FA05Y >= FA07Y + 50) AND (FP04Y <=
						FP05Y - 50) AND (FA06X >= FA10X + 50) AND
						(FP03X <= FP08X - 50)

Code *DIS021*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Translation of the	Hip	60	60	HIAB_L.C.,HIAD_R.C,HIAB_R.S,HIA D_L.S	(FA10X >= FA17X + 20) AND (FA10X < FA17X + 40)
2	Translation of the	Hip	60	120	HIAB_L.C,HIAD_R.C,HIAB_R.S,HIA D_L.S	(FA10X >= FA17X + 40)

Code *DIS022*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Translation of the	Hip	60	60	HIAB_R.C,HIAD_L.C,HIAB_L.S,HIAD_R.S	(FA17X >= FA10X + 20) AND (FA17X < FA10X + 40)
2	Translation of the	Hip	60	120	HIAB_R.C,HIAD_L.C,HIAB_L.S,HIAD_R.S	(FA17X >= FA10X + 40)

Code *DIS023*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Anterior translatio	Hip +	61	61	HIEX.C,HIFL_L.S,HIFL_R.S	(SD07X >= SD11X + 20) AND (SD07X < SD11X + 40)
2	Anterior translatio	Hip +	61	122	HIEX.C,HIFL_L.S,HIFL_R.S	(SD07X >= SD11X + 40)

Code *DIS024*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Posterior translatio	Hip +	61	61	HIFL_L.C,HIFL_R.C,HIEX_L.S,HIEX_R.S	(SD11X >= SD07X + 20) AND (SD11X < SD07X + 40)
2	Posterior translatio	Hip +	61	122	HIFL_L.C,HIFL_R.C,HIEX_L.S,HIEX R.S	(SD11X- SD07X + 40)

Code *DIS025*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*

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1	Anterior pelvic tilt	Hip +	61	61	TRFL.C,HIEX.C,TRLE.S,HIFL_L.S,H	(SD07X - SD09X >= 10) AND (SD07X - SD09X <
					IFL_R.S,HIEX_L.S,HIEX_R.S	20)
2	Anterior pelvic tilt -	Hip +	61	122	TRFL.C,HIEX.C,TRLE.S,HIFL_L.S,H	(SD07X - SD09X >= 20)
					IFL_R.S,HIEX_L.S,HIEX_R.S	

Code *DN026*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Posterior pelvic tilt	Hip +	61	61	TRLE.C,HIFL_L.C,HIFL_R.C,TRFL.S	(SD09X - SD07X >= 10) AND (SD09X - SD07X <
					,HIEX_L.S,HIEX_R.S	20)
2	Posterior pelvic tilt	Hip +	61	122	TRLE.C,HIFL_L.C,HIFL_R.C,TRFL.S	(SD09X - SD07X >= 20)
					,HIEX_L.S,HIEX_R.S	

Code DIS029

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral elevation o	Hip	60	60	TRLE.C,TRTE.C,TRFL.S,TRLF_R.C, TRLF_L.S	(FA11 - FA09 >=10) AND (FA11 - FA09 < 20)
2	Lateral elevation o	Hip	60	120	TRLE.C,TRTE.C,TRFL.S,TRLF_R.C, TRLF_L.S	(FA11 - FA09 >= 20)

Code DIS030

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral elevation o	Hip	60	60	TRLE.S,TRTE.S,TRFL.C,TRLF_L.C, TRLF_R.S	(FA09 - FA11 >= 10) AND (FA09 - FA11 < 20)
2	Lateral elevation o	Hip	60	120	TRLE.S,TRTE.S,TRFL.C,TRLF_L.C, TRLF R.S	(FA09 - FA11 >= 20)

Code DIS031

Level	Name	Group	Factor	Priority	Actions	Formula
1	Plantar flexion of t	Unknown	0	0	ANDF_R.C,ANPF_R.S	(SD10X - SD11X >= 20) AND (SD10X - SD11X < 40)
2	Plantar flexion of t	Unknown	0	0	ANDF_R.C,ANPF_R.S	(SD10X - SD11X >= 40)

Code DIS032

Level	Name	Group	Factor	Priority	Actions	Formula

SUBSTITUTE SHEET (RULE 26)

1	Dorsiflexion of the	Unknown	0	0	ANPF_R.C,ANDF_R.S	(SD11X - SD10X >= 20) AND (SD11X - SD10X < 40)
2	Dorsiflexion of the	Unknown	0	0	ANPF_R.C,ANDF_R.S	(SD11X -SD10X >= 40)

Code *DIS033*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Internal rotation of	Ankle +	11	11	HIFL_R.C,HIEX_R.C,HIER_R.C,HIF L_LS,HIEX_LS,ANEV R.C	(FA19X - FA16X >= 10) AND (FA19X - FA16X < 20)
2	Internal rotation of	Ankle +	11	22	HIFL_R.C,HIEX_R.C,HIER_R.C,HIF L_LS,HIEX_LS,ANEV_R.C	(FA19X - FA16X >= 20)

Code *DIS034*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	External rotation o	Ankle +	11	11	HIIR_R.C,HIFL_R.S,HIEX_R.S,HIER_R.S,ANIN_R.C	(FA16X - FA19X >=10) AND (FA16X - FA19X < 20)
2	External rotation o	Ankle +	11	22	HIIR_R.C,HIFL_R.S,HIEX_R.S,HIER_R.S,ANIN_R.C	(FA16X - FA19X >= 20)

Code *DIS037*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Genu valgum right	Knee	20	20	HIAD_R.C,HIAB_R.S	(FA14X - FA09X >= 10) AND (FA14X - FA16X >= 10) AND ((FA14X - FA09X < 20) OR (FA14X - FA16X < 20))
2	Genu valgum right	Knee	20	40	HIAD_R.C,HIAB_R.S	(FA14X - FA09X >= 20) AND (FA14X - FA16X >= 20)

Code *DIS038*

Level	*Name*	*Group*	*Factor*	*Priority*	*Actions*	*Formula*
1	Genu valgum left	Knee	20	20	HIAD_L.C,HIAB_L.S	(FA11X - FA15X >= 10) AND (FA18X - FA15X >= 10) AND ((FA11X - FA15X < 20) OR (FA18X - FA15X < 20))
2	Genu valgum left -	Knee	20	40	HIAD_L.C,HIAB_L.S	(FA11X - FA15X >= 20) AND (FA18X - FA15X >=

SUBSTITUTE SHEET (RULE 26)

20)

Code DIS039

Level	Name	Group	Factor	Priority	Actions	Formula
1	Genu varum right	Knee	20	20	HIAB_R.C,HIAD_R.S	(FA09X - FA14X >= 10) AND (FA16X - FA14X >= 10) AND ((FA09X - FA14X < 20) OR (FA16X - FA14X < 20))
2	Genu varum right - Knee		20	40	HIAB_R.C,HIAD_R.S	(FA09X - FA14X >= 20) AND (FA16X - FA14X >= 20)

Code *DIS040*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Genu varum left	Knee	20	20	HIAB_L.C,HIAD_L.S	(FA15X - FA11X >= 10) AND (FA15X - FA18X >= 10) AND ((FA15X - FA11X < 20) OR (FA15X - FA18X < 20))
2	Genu varum left -	Knee	20	40	HIAB_L.C,HIAD_L.S	(FA15X - FA11X >= 20) AND (FA15X - FA18X >= 20)

Code *DIS041*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Anterior deviation	Shoulder	30	30	SCAD.C,SHFL.S,SHIR.S	(SD04X - SD01X >= 10) AND (SD04X - SD07X >= 10) AND ((SD04X - SD01X < 20) OR (SD04X - SD07X < 20))
2	Anterior deviation	Shoulder	30	60	SCAD.C,SHFL.S,SHIR.S	(SD04X - SD01X >= 20) AND (SD04X - SD07X >= 20)

Code *DIS042*

Level	*Name*	*Group*	*Factor*	*Priority*	Actions	*Formula*
1	Posterior deviation	Shoulder	30	30	SCAD.S,SHFL.C,SHIR.C,SCAB.C	(SD01X - SD04X >= 10) AND (SD07X - SD04X >=10) AND ((SD01X - SD04X < 20) OR (SD07X - SD04X < 20))

SUBSTITUTE SHEET (RULE 26)

2	Posterior deviation	Shoulder	30	60	SCAD_S,SHFL_C,SHIR_C,SCAB_C	(SD01X - SD04X >= 20) AND (SD07X - SD04X >= 20)

Code DIS043

Level	Name	Group	Factor	Priority	Actions	Formula
1	External rotation o	Ankle +	11	11	HIIR_LC,HIFL_LS,HIEX_LS,HIER_LS,ANIN_LC	(FA20X - FA18X >= 10) AND (FA20X - FA18X < 20)
2	External rotation o	Ankle +	11	22	HIIR_LC,HIFL_LS,HIEX_LS,HIER_LS,ANIN_LC	(FA20X - FA18X >= 20)

Code DIS044

Level	Name	Group	Factor	Priority	Actions	Formula
1	Internal rotation of	Ankle +	11	11	HIFL_LC,HIEX_LC,HIER_LC,HIFL_R,S,HIEX_R,S,ANEV_LC	(FA18X - FA20X >=10) AND (FA18X - FA20X < 20)
2	Internal rotation of	Ankle +	11	22	HIFL_LC,HIEX_LC,HIER_LC,HIFL_R,S,HIEX_R,S,ANEV_LC	(FA18X - FA20X >= 20)

As stated previously, each deviation is linked to corrective actions and these actions, in turn, are linked to appropriate exercises and stretching routines to treat the deviation. The corrective actions are linked to their deviations by a code that specifies the type of action and exercise required to correct the identified deviation. Every exercise is associated with a level of difficulty from one to three. When beginning a biomechanical assessment, the health-care professional indicates his client's activity level from one to three (level 1 = inactive, level 2 = moderately active, level 3 = highly active and * = all levels of activity). Only those exercises matching the client's activity level are selected to treat any particular deviation.

A client's exercise schedule is divided into three sessions: the first is of two weeks in duration and the last two are of four weeks duration. When an action group contains numerous exercises, the system always selects only the first three exercises and inserts one into each session. When there is only one exercise applicable, it is included in all three sessions. If there are two exercises applicable, the first is slotted into session 1, and the second one into sessions 2 and 3. There is a maximum of twelve exercises applicable per session. When the system calculates more than twelve exercises applicable per session, the user is requested to delete a deviation. This self-regulating process ensures that the entire 10 –week exercise program does not include more than thirty-six exercises, and that not more than 12 are prescribed in one week in order to respect a maximum time budget allowed.

In one other embodiment of the present invention, an artificial neural network is trained to select exercises based on biomechanical segments points coordinates without passing through all previously shown calculations.

The patient's personal information, images, biomechanical assessment, postural deviations, corrective actions and associated exercises and stretches are presented in the Biomechanical Assessment Report that is printed by the practitioner. A page from a sample Biomechanical Assessment Report is presented in Figure 13. Presented are personal information on the patient (1), lateral view image of the patient with markers (2), and biomechanical parameters. Presented in Figure 14 is a page from the same sample Biomechanical Assessment Report that includes specification of the patient's postural deviations and the associated exercises and stretching. Presented in

Fig. 15 is a page from the Postural Analysis Report that displays the exercise schedule generated in the Biomechanical Assessment process. This figure details the personalized exercise routines for the 10-week treatment period. Finally, presented in Fig. 16 is another page from the Biomechanical Assessment Report illustrating and describing a few of the exercises of the exercise schedule. All of the above information is generated automatically (and modifiable manually) by the system.

In a preferred embodiment of the present invention, after the patient has completed the exercise routines, he or she can return for a follow-up evaluation. Feedback is given by the health-care practitioner and new images of the patient are taken in order to reevaluate deviations and priorities. A comparative Biomechanical Assessment Report is generated comparing two assessments. The goal is to assess the effects of treatment and modify the exercise regime, if necessary. A quantified analysis of improvement is therefore provided and both the patient and health-care practitioner can visualize progress towards ideal postural alignment. In another embodiment of the present invention, feedback is provided directly by the patient through the web site, such information being used as a complement in the postural evaluation and in further exercise selection.

Importantly, all biomechanical data linked to personal information parameters such as height, weight, and age are stored centrally. In one embodiment of the invention, correlation is executed between the personal information parameters, the exercises selected in the Biomechanical Assessment and between the improvement of the patient's condition. This correlation allows the determination of the exercises which are more efficient for the different elements associated with the patient such as the deviation severity, the age, the gender or the activity level. Parameters used in deviation-exercises correlation are adjusted based on the effectiveness of the exercise program to correct deviations and the exercise program is repeatedly varied until the effectiveness of the exercises is optimized. An important advantage of having calculations performed centrally rather than on locally arranged software, is that improvements and modifications to the system can be made instantaneously across users without delays cause by the more standard transmission of software updates. This is a highly distinguishing aspect of our Biomechanical Assessment system. An additional distinguishing feature is that biomechanical assessments can be performed

at remote locations, as the digital image acquisition can be performed virtually anywhere. Web-based technology is ideally placed to bring cutting-edge health care to potentially disadvantage geographical locations.

While the invention has been described in con-nection with specific embodiments thereof, it will be understood that it is capable of further modification and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be applied to the essential features here in before set forth, and as follows in the scope of the appended claims.

CLAIMS

1. A method of acquiring biomechanical position data for use in postural analysis, the method comprising the steps of:

a) selecting a plurality of marker positions referenced with respect to an anatomy of a patient by one of:

skin surface features having minimal variability from one patient to the next; and

skeletal features palpable from a skin surface of the patient;

b) attaching a scanable marker on the patient at each of the marker positions, the step of attaching including palpating the patient to define at least some of the marker positions;

c) instructing the patient to stand relaxed and in normal posture; and

d) scanning the markers attached to the patient to obtain position data for each of the marker positions.

2. The method as claimed in claim 1, wherein the patient is scanned from a front, side and rear viewpoint.

3. The method as claimed in claim 2, wherein the step of scanning comprises photographing the patient against a backdrop, the markers comprising contrasting visual

4. The method as claimed in claim 3, wherein the step of photographing comprises using a digital camera with a flash to obtain digital images, the markers comprising retroreflective markers.

5. The method as claimed in claim 4, wherein some of the markers are scanned from more than one of the viewpoints and comprise retroreflective spheres.

6. The method as claimed in claim 3, wherein the step of instructing the patient to stand relaxed and in normal posture comprises requesting the patient to walk in place prior to standing still.

7. The method as claimed in claim 4, wherein the step of scanning comprises automatically recognizing the markers and the reference marker points in the digital images using a computer.

8. The method as claimed in claim 7, wherein the computer comprises a user interface and, when the computer recognizes too many or too few of the markers, input is accepted via the user interface to remove or add, with reference to the digital images, the position coordinates of the markers which the computer incorrectly recognized or failed to recognize.

9. A method for calculating postural deviation values in a patient comprising the steps of:

a) obtaining position data identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising head-shoulders, shoulders- pelvis, pelvis-hips, hips-knees and knees-ankles;

b) obtaining weight data of the patient;

c) calculating vertical and horizontal plumb line using the position data;

d) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data.

10. The method as claimed in claim 9, wherein the angle and distance of deviation values are referenced with respect to average or normal values.

11. The method as claimed in claim 9, further comprising a step of calculating an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.

12. The method as claimed in claim 9, wherein the deviation values are calculated for all of the body segments.

13. A method of selecting exercises for improving tonicity and correcting posture in a patient, the method comprising the steps of:

a) obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data indicative of postural problems requiring correction;

b) ranking the postural deviations by severity and priority;

c) correlating the position data with exercises for strengthing or stretching specific muscles or muscle groups to obtain ranking data for the exercises;

d) compiling an exercise program for the patient based on the ranking data.

14. The method as claimed in claim 13, wherein the step of compiling comprises manually selecting exercises from a ranked list of exercises.

15. The method as claimed in claim 14, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

16. The method as claimed in claim 13, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

17. The method as claimed in claim 13, wherein the position data identifies a position in space of body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the step of correlating comprises:

a) calculating a center of mass plumb line position value using the position data and the weight data;

b) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data;

c) comparing the deviation values to normal values for the at least some of the body segments to obtain deviation priority values;

d) ranking the deviation priority values according to an order of severity or importance; and

e) determining the ranking data based on an association of the exercises with body segment deviations in accordance with the order of severity or importance.

18. The method as claimed in claim 17, wherein the step of ranking the deviation priority values according to an order of severity or importance comprises manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations manually selected.

19. The method as claimed in claim 18, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, and the exercise program comprising a series of the sets of exercises.

20. The method as claimed in claim 19, wherein the exercise program is limited to a maximum number of exercises, the step of manually selecting deviations is automatically restricted when a maximum number of exercises corresponding to the selected deviations exceeds the maximum number for the exercise program.

21. The method as claimed in claim 13, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

22. The method as claimed in claim 21, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

23. The method as claimed in claim 17, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

24. The method as claimed in claim 23, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

25. The method as claimed in claim 13, further comprising steps of:

a) obtaining, after completing of the exercise program, new biomechanical position data of the patient while standing relaxed and in normal posture;

b) evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems; and

c) adjusting parameters used in the step of correlating for future patients based on the effectiveness evaluated in the previous step.

26. The method as claimed in claim 25, wherein the exercise program is repeatedly varied until the effectiveness of the exercises is optimized.

27. The method as claimed in claim 26, wherein the steps of correlating, evaluating and adjusting are carried out using a centralized shared database of the parameters used in the step of correlating for a large number of patients.

28. The method as claimed in claim 25, wherein the parameters include at least one of age, gender and an activity level of the patient.

29. A method of providing posture health care using a distributed system, the method comprising the steps of:

a) obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;

b) processing the personal and position data using data stored in a remote central database to obtain preliminary postural deviation assessment data;

c) providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;

d) obtaining corrected postural deviation assessment data from one of the health-care practitioner and the patient; and

e) modifying the data stored in the central database using the corrected data.

30. The method as claimed in claim 29, wherein the preliminary postural deviation assessment data comprises a ranked list of deviations and a preliminary selection of the deviations to be included in a therapeutic exercise program, and the corrected data comprises a corrected selection of the deviations to be included in a therapeutic exercise program.

31. The method as claimed in claim 29, wherein:

the preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

the corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

step (e) comprises processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and modifying accordingly the data stored in the central database.

32. The method as claimed in claim 29, wherein:

step (a) comprises validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a central server;

step (b) is a carried out at the central server;

step (c) comprises transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;

step (d) comprises transmitting the corrected data to the central server; and

step (e) is carried out by the central server.

33. The method as claimed in claim 32, wherein the biomechanical measurement station includes a health-care practitioner client station in communication with the central server.

34. The method as claimed in claim 33, wherein the client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

35. An apparatus for acquiring biomechanical position data for use in postural analysis of a patient, the apparatus comprising:

a) scanable markers for attaching on said patient at preselected marker positions; and

b) scanner for obtaining position data for each of the marker position.

36. The apparatus of claim 35, wherein the markers comprise an adhesive layer for sticking to the patient.

37. The apparatus of claim 35, wherein the markers further comprise retroreflective material.

38. The apparatus of claim 37, wherein said scanner is a digital camera with a flash for obtaining digital images.

39. The apparatus of claim 38, further comprising a computer for automatically recognizing the markers and for referencing marker points in digital images.

40. The apparatus of claim 39, wherein the computer comprises a user interface for removing incorrectly recognized markers by the computer or for adding the position

coordinates of the markers with reference to the digital images, for the markers which the computer failed to recognize.

41. An apparatus for calculating postural deviation values in a patient comprising:

a) position data acquisition device for identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles;

b) weight data acquisition device for obtainer weight data of the patient;

c) vertical and horizontal plumb lines determination device using the position data;

d) angle of deviation and distance of deviation determination device for determining at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data.

42. The apparatus of claim 41, wherein said angle of deviation and distance of deviation determination device refers said angle and distance of deviation values with respect to average or normal values.

43. The apparatus of claim 41, further comprising an effective weight or stress determination device for determining an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.

44. The apparatus of claim 41, wherein the determination device calculates deviation values for all of the body segments.

45. An apparatus for selecting exercises for improving tonicity and correcting posture in a patient, the apparatus comprising:

a) a biomechanical position data acquisiton device for obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data being indicative of postural problems requiring corrections;

b) ranking means for ranking the postural deviations by severity and priority;

c) a correlator for correlating the position data with exercises for strengthening or stretching specific muscles or muscle groups to obtain ranking data for the exercises; and

d) a compilor for compiling an exercise program for the patient based on the raking data.

46. The apparatus of claim 45, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the correlator correlating the position data with the sets of exercises, and the exercise program comprises a series of the sets of exercises.

47. The apparatus of claim 45, wherein the position data identifies a position in space of a body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the correlator comprising:

a) a center of mass plumb line position determination device for determining a center of mass plumb line position value using the position data and the weight data;

b) a angle of deviation and distance of deviation determination device for determining for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data;

c) a deviation values comparison means for comparing the deviations values to normal values for the at least some of the body segments to obtain deviation priority values;

d) ranking means for ranking the deviation priority values according to an order of severity or importance; and

e) a ranking data with body segment deviations determination device for determining the ranking data based on an association of the exercises with body segment deviations in accordance with the order of severity or importance.

48. The apparatus of claim 47, wherein said ranking means performs ranking of the deviation priority values accordingly to an order of severity or importance comprising manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations manually selected.

49. The apparatus of claim 48, wherein said compiling means is repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

50. The apparatus of claim 49, wherein said compiling means further include ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

51. The apparatus of claim 48, wherein said compiling means repeat ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

52. The apparatus of claim 51, wherein said compiling means further include ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

53. The apparatus of claim 45, further comprising:

- effectiveness of the exercises evaluator for evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems based on new biomechanical position data of the patient obtained while standing relaxed and in normal posture after completion of the exercise program; and

- parameters adjustment means for adjusting parameters used in correlation for future patients based on the effectiveness evaluated.

54. The apparatus of claim 53 further comprising a centralized shared database used for correlating, evaluating and adjusting for a large number of patients.

55. An apparatus for providing posture health care using a distributed system comprising:

a) a personal data obtainer for obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;

b) a personal and position data processor for processing the personal and position data using data stored in a remote central database to obtain preliminary postural deviation assessment data;

c) a preliminary postural deviation provider for providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;

d) a corrected postural deviation assessment data obtainer for obtaining corrected postural deviation assessment data from one of the health-care practitionner and the patient; and

e) a data modifier to modify the data stored in the central database using the corrected data.

56. The apparatus of claim 55, wherein:

said preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

said corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

said data modifier comprises processor for processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and modifying accordingly the data stored in the central database.

57. The apparatus of claim 55, wherein:

said personal data acquisition device comprises validation means for validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a central server;

said personal and position data processor is at the central server;

said preliminary postural deviation provider comprises transmitting means for transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;

said corrected postural deviation assessment data acquisition data comprises transmitting means for transmitting the corrected data to the central server; and

said data modifier is at the central server.

58. The apparatus of claim 57, wherein said client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

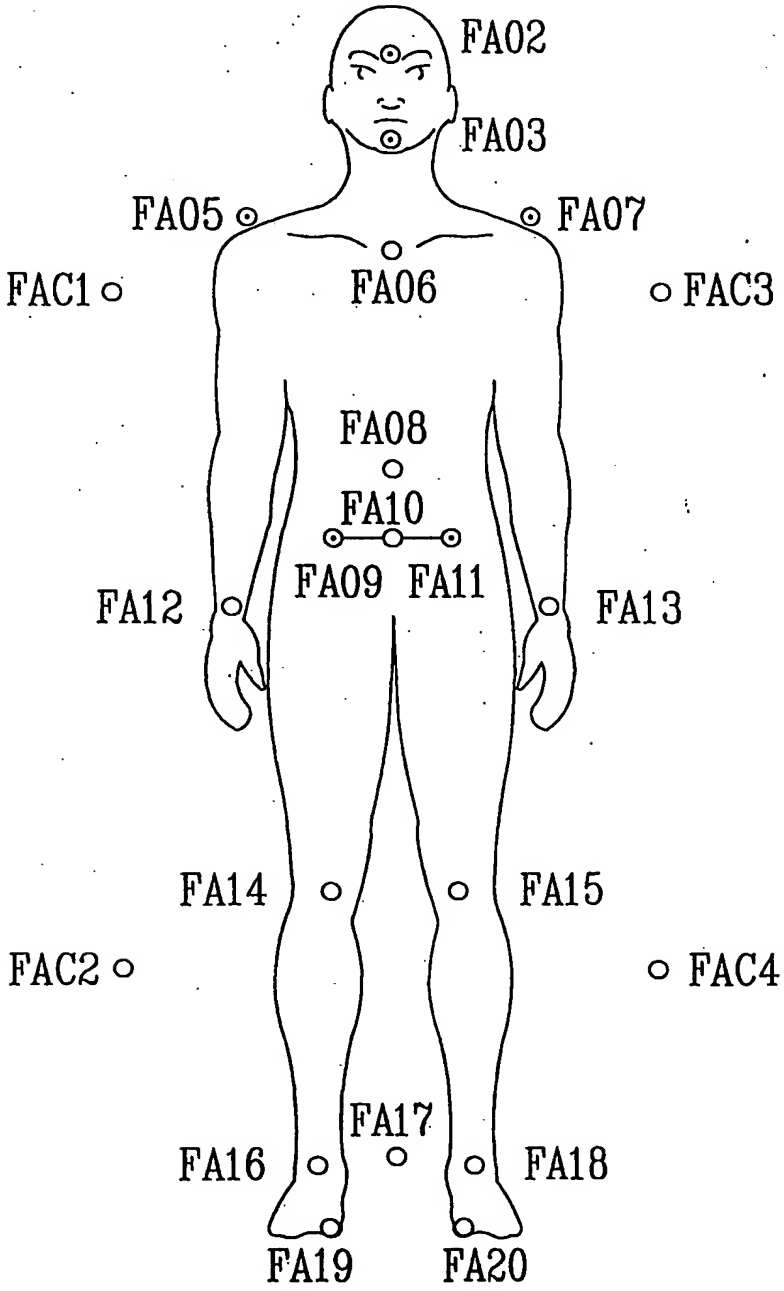

FA02
FA03
FA05
FA07
FAC1
FA06
FAC3
FA08
FA10
FA09
FA11
FA12
FA13
FA14
FA15
FAC2
FAC4
FA17
FA16
FA18
FA19
FA20

FIG. 1

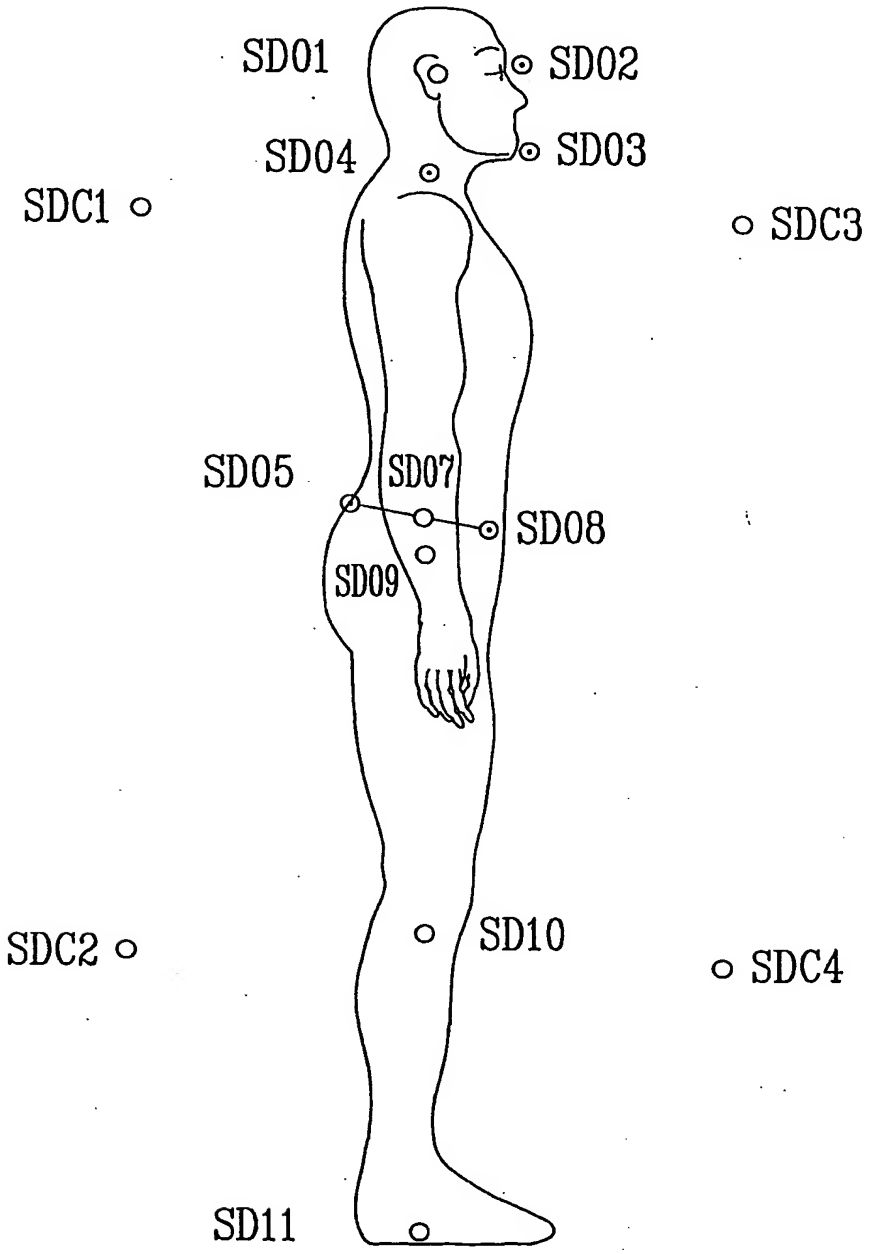

SD01
SD02
SD04
SD03
SDC1
SDC3
SD05
SD07
SD08
SD09
SDC2
SD10
SDC4
SD11

FIG_2A

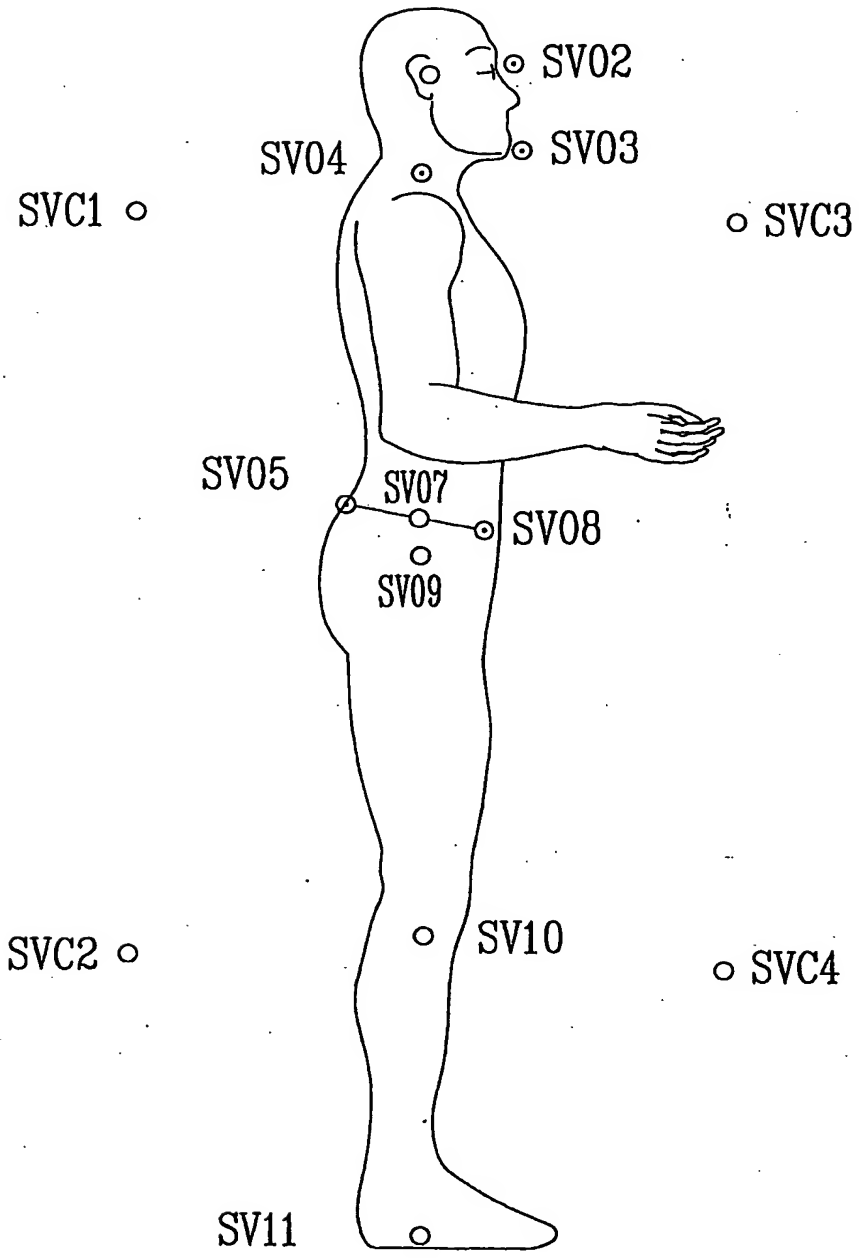

SV02
SV03
SV04
SVC1
SVC3
SV05
SV07
SV08
SV09
SVC2
SV10
SVC4
SV11

FIG. 2B

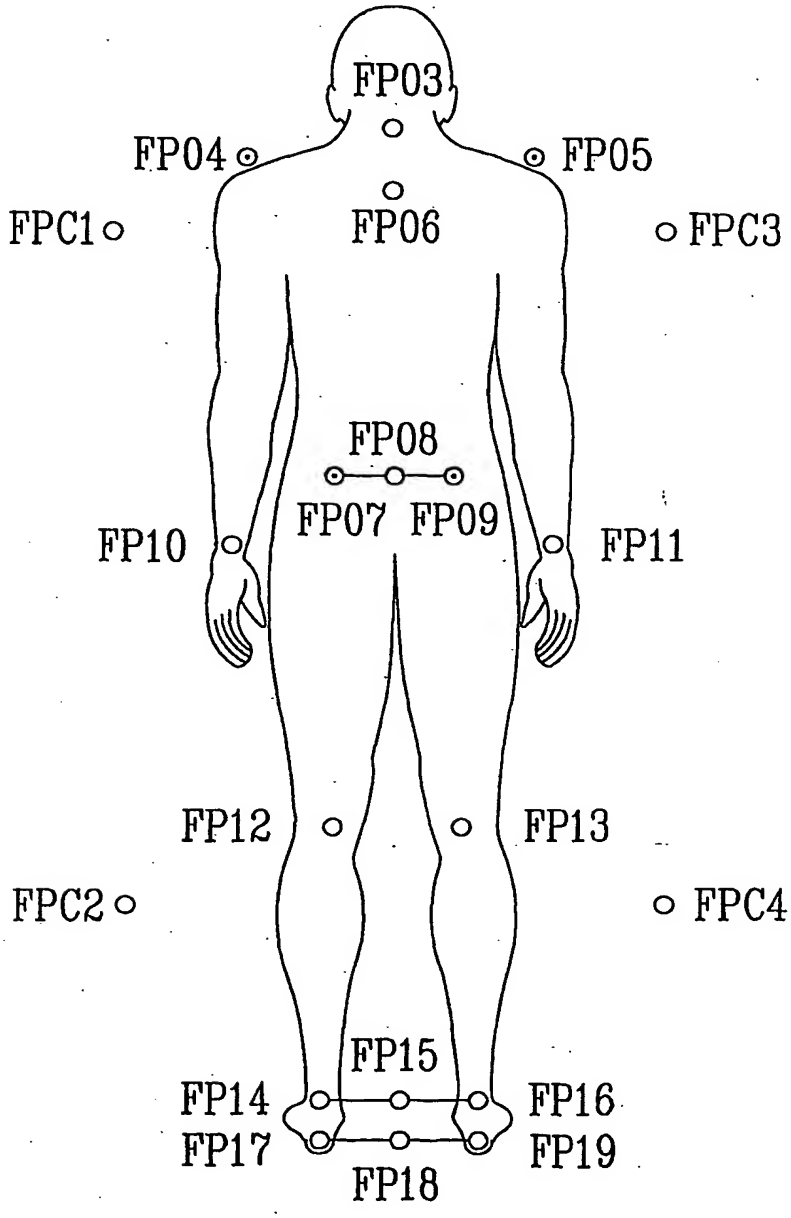

FP03
FP04
FP05
FPC1
FP06
FPC3
FP08
FP07
FP09
FP10
FP11
FP12
FP13
FPC2
FPC4
FP15
FP14
FP16
FP17
FP19
FP18

FIG_3

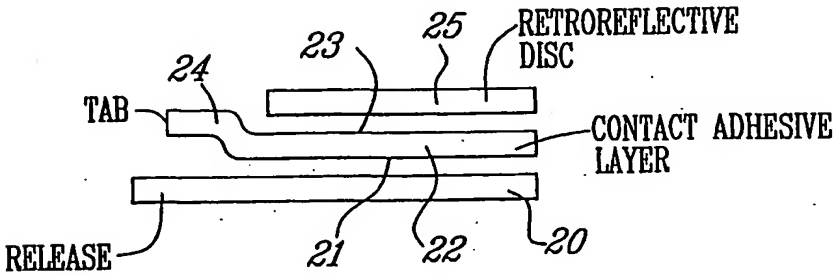
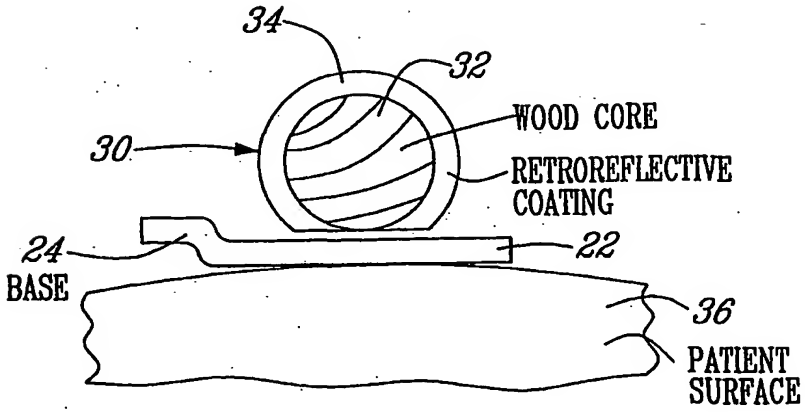

25
RETROREFLECTIVE DISC
23
24
TAB
CONTACT ADHESIVE LAYER
RELEASE
21
22
20

FIG_4


34
32
WOOD CORE
30
RETROREFLECTIVE COATING
24
22
BASE
36
PATIENT SURFACE

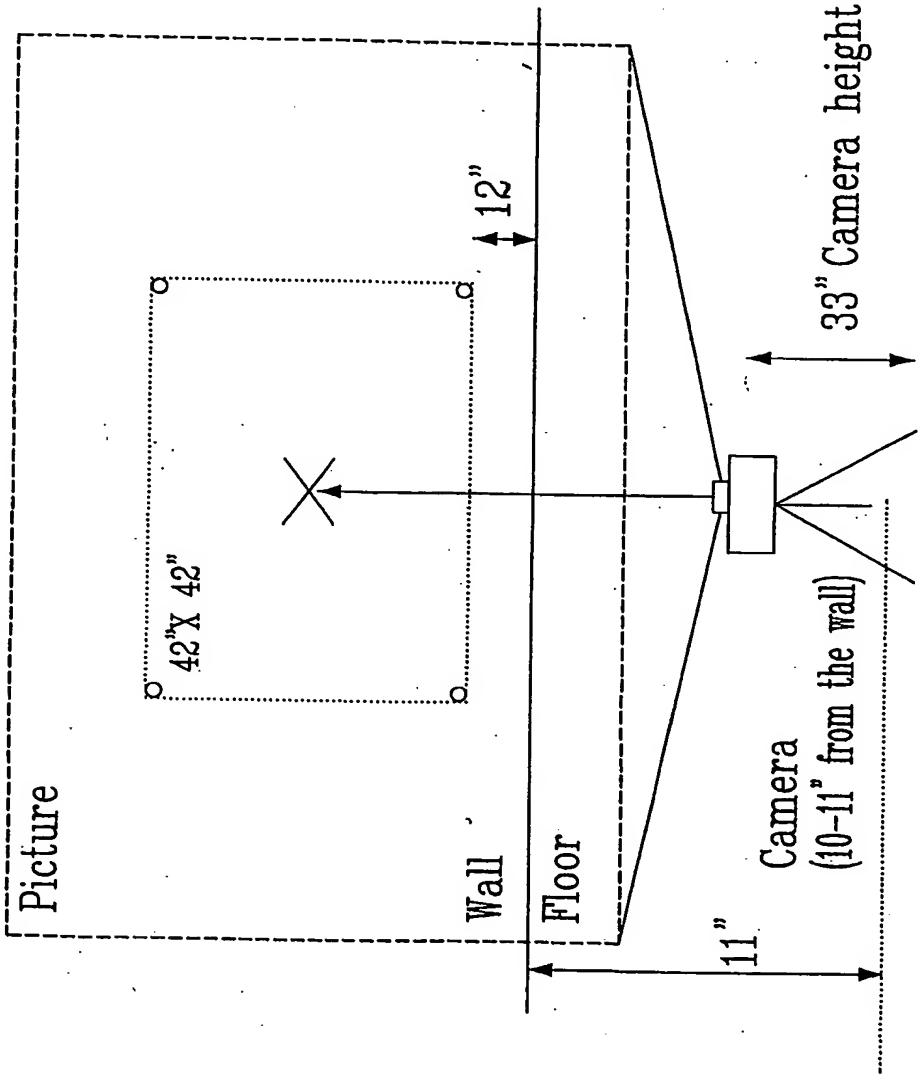

Picture
42"X 42"
12"
33" Camera height
Wall
Floor
11"
Camera
(10-11" from the wall)

FIG. 6

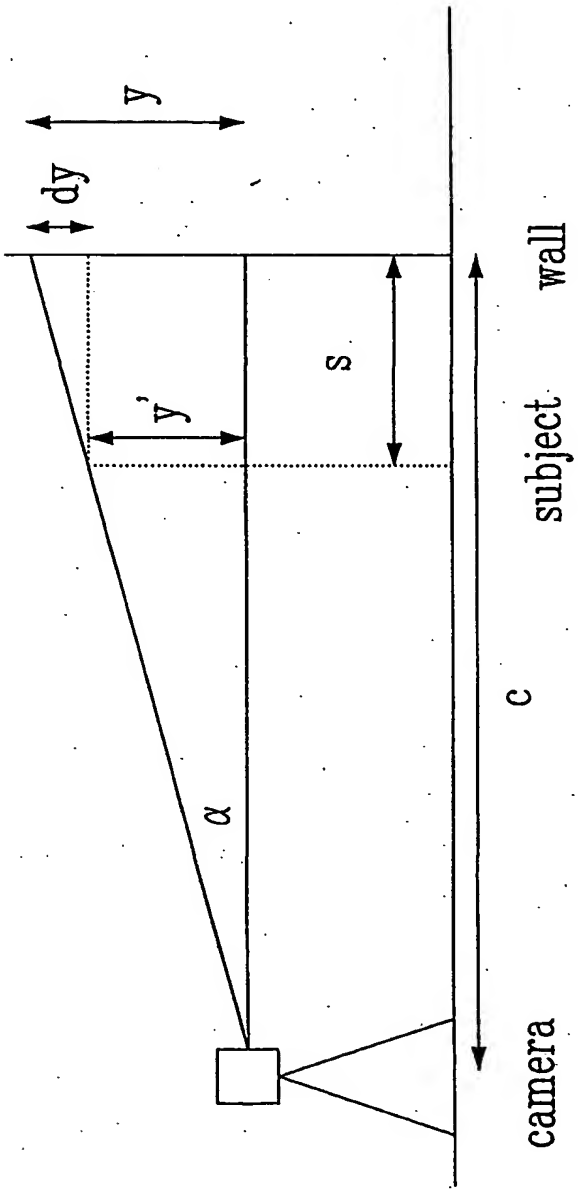


FIG_7

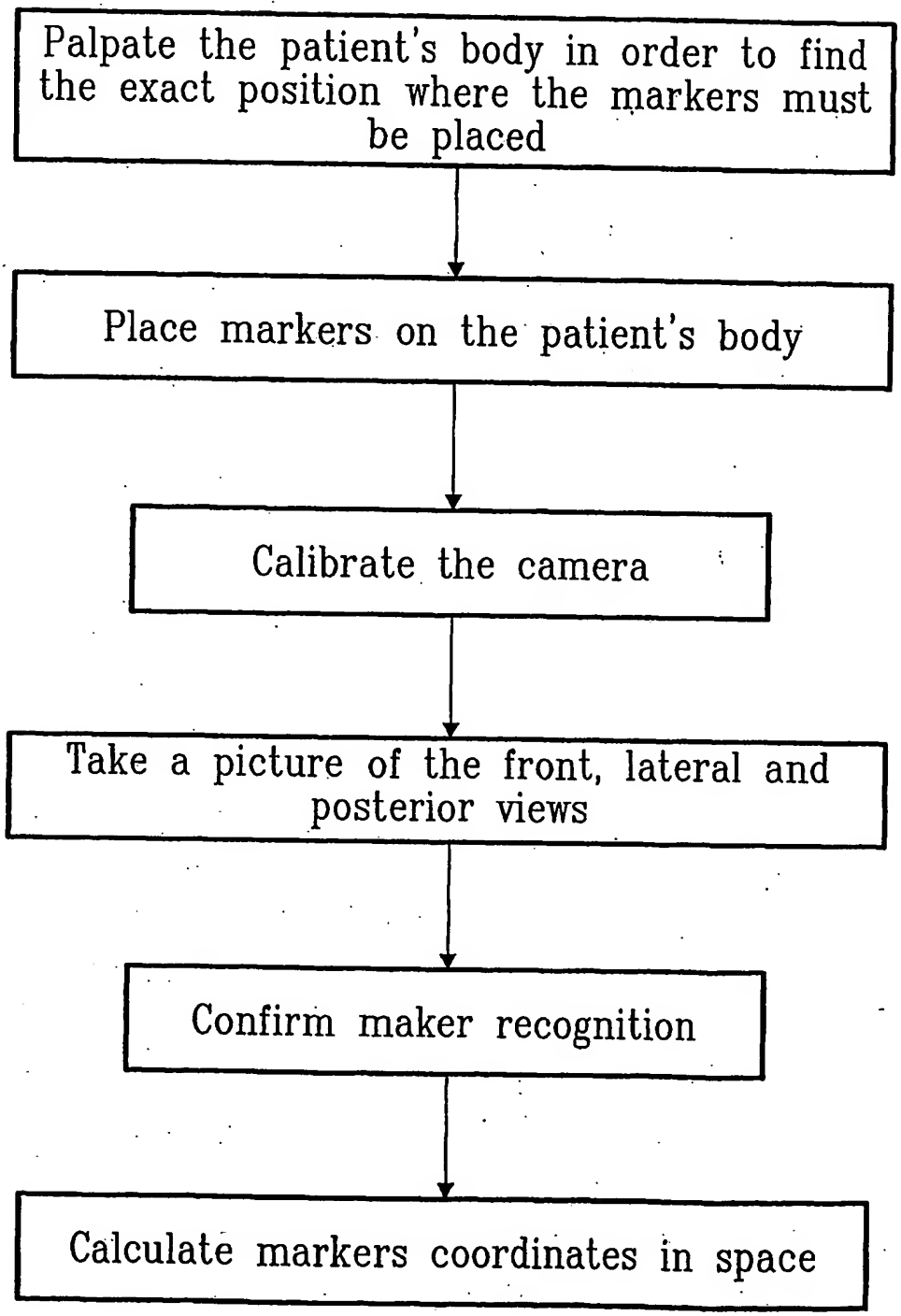

Palpate the patient's body in order to find the exact position where the markers must be placed
Place markers on the patient's body
Calibrate the camera
Take a picture of the front, lateral and posterior views
Confirm maker recognition
Calculate markers coordinates in space

FIG_8

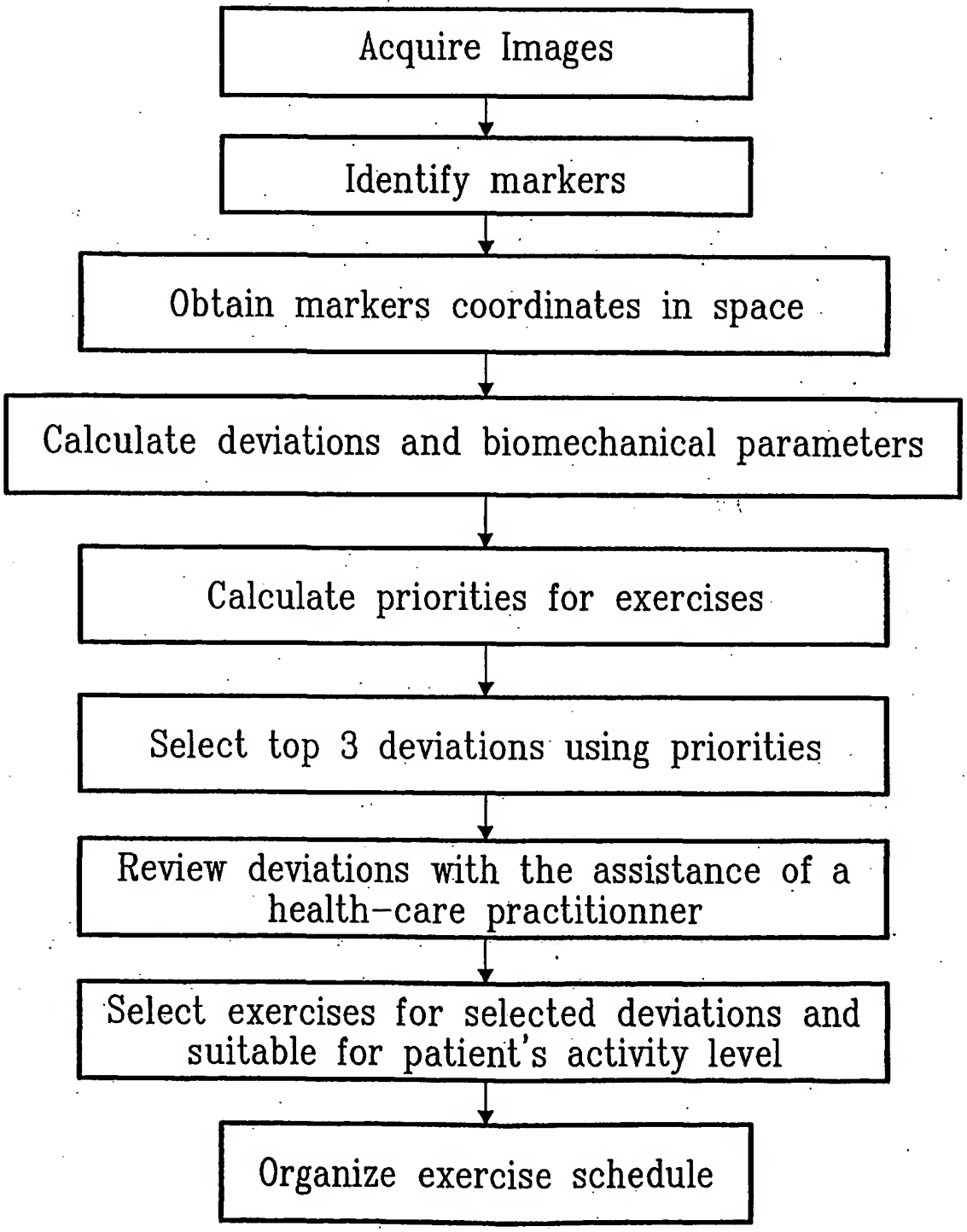

Acquire Images
Identify markers
Obtain markers coordinates in space
Calculate deviations and biomechanical parameters
Calculate priorities for exercises
Select top 3 deviations using priorities
Review deviations with the assistance of a health-care practitionner
Select exercises for selected deviations and suitable for patient's activity level
Organize exercise schedule

FIG_9

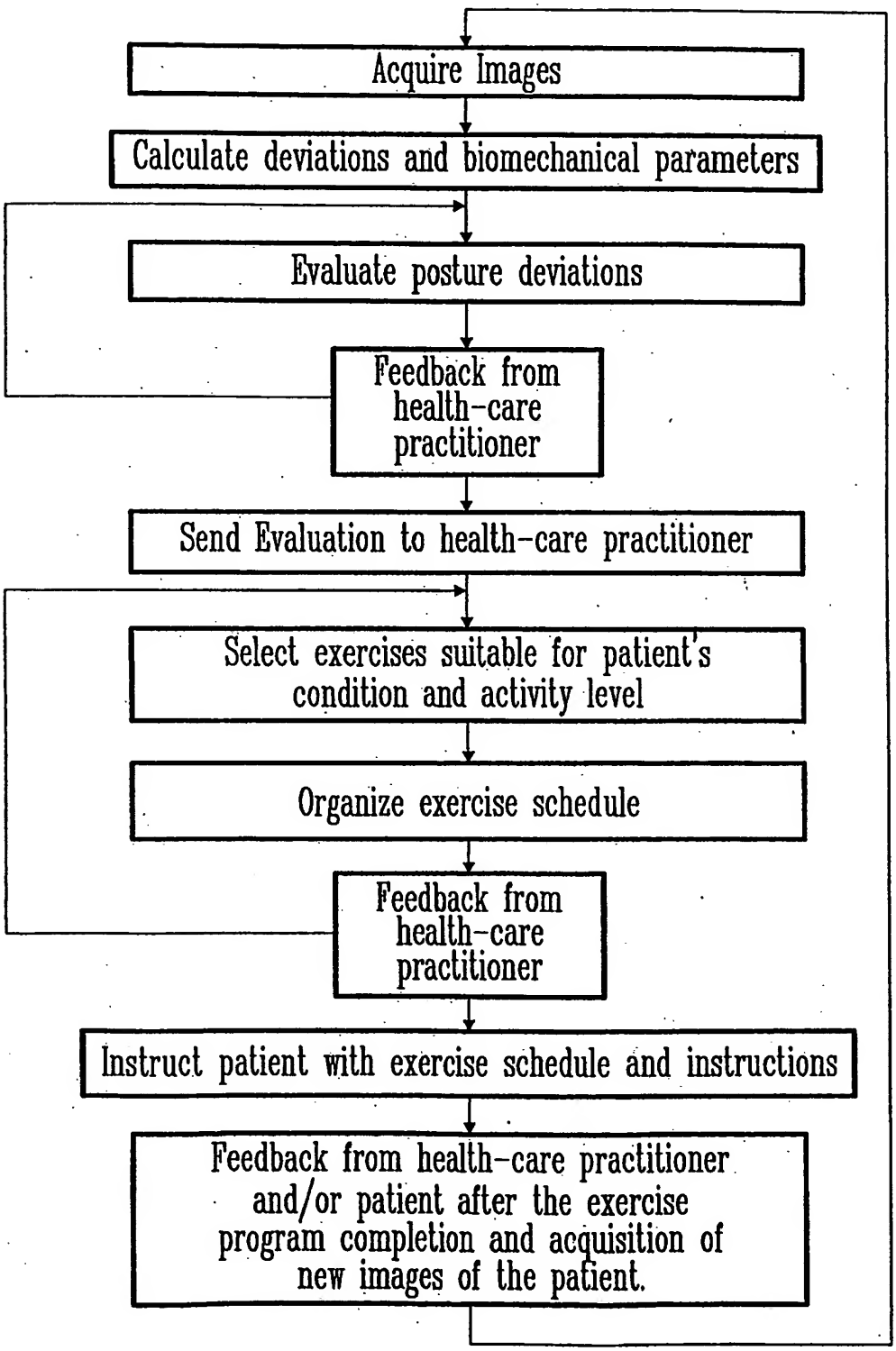

Acquire Images
Calculate deviations and biomechanical parameters
Evaluate posture deviations
Feedback from health-care practitioner
Send Evaluation to health-care practitioner
Select exercises suitable for patient's condition and activity level
Organize exercise schedule
Feedback from health-care practitioner
Instruct patient with exercise schedule and instructions
Feedback from health-care practitioner and/or patient after the exercise program completion and acquisition of new images of the patient.

FIG_10

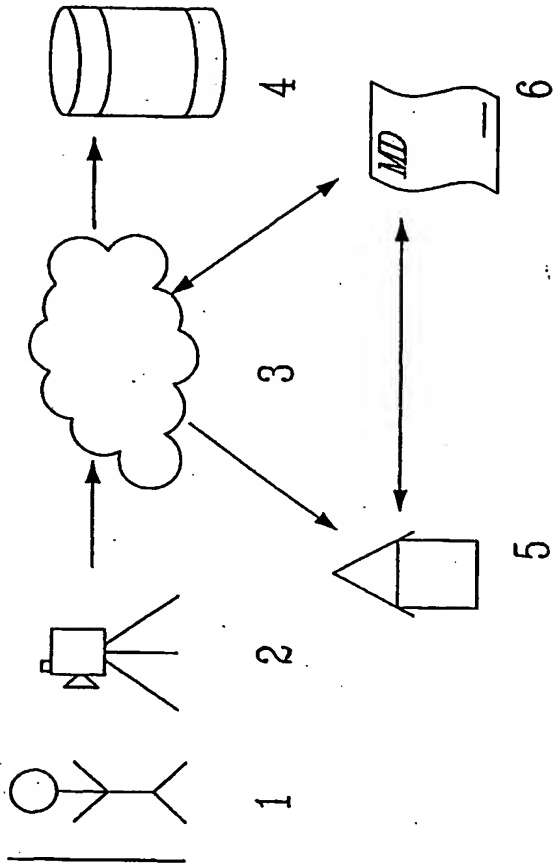
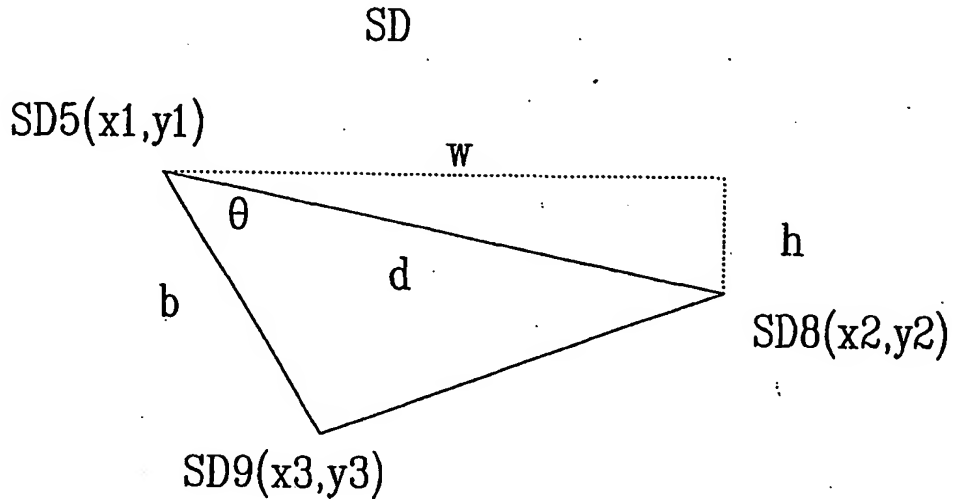


FIG. 11


SD
SD5(x1,y1)
w
θ
h
d
b
SD8(x2,y2)
SD9(x3,y3)

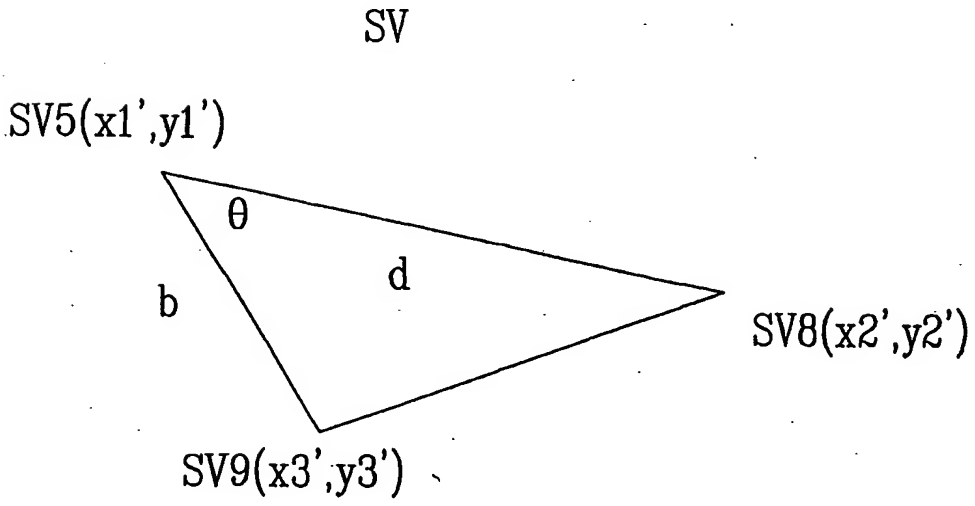

SV
SV5(x1',y1')
θ
d
b
SV8(x2',y2')
SV9(x3',y3')

FIG_12

Identification

User ID :	jf1708200002
Name:	Posterior Head Translation
Birthdate :	Thursday, January 01, 1970
Sex:	Male
Height :	67.0 in
Weight:	170.0 lbs
Activity Level:	Inactive

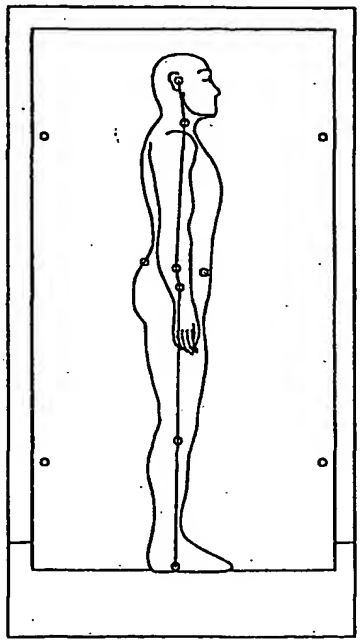
Evaluator : Jean-Francois Normandin

Lateral View

Deviations from Vertical Alignment

Segment	Direction	Angle
Head to Shoulders	Posterior	8.5 °
Shoulders to Pelvis	Anterior	3.8 °
Pelvis to Hips	Posterior	13.0 °
Hips to Knees	Posterior	1.5 °
Knees to Feet	Anterior	2.9 °

Note: The ideal angle should be 0°.



Distances from the Vertical Axis

Reference Point on	Direction	Distance
Head		0.0 in
Shoulders	Anterior	0.7 in
Pelvis	Posterior	0.4 in
Hips	Anterior	0.4 in
Knees	Anterior	0.8 in

Note: The ideal distance should be 0 in.

Moments of Force and Reaction Forces

Segment	Actual weight	Lever arm	Moment of force	Joint reaction force	Effective weight
Head	14.3 lbs	0.7 in	-1.2 Nm ↷	92.8 N	20.9 lbs
Head and Trunk	113.6 lbs	0.4 in	5.3 Nm ↶	611.5 N	137.6 lbs

FIG 13

Postural Deviations and Associated Exercises and Stretching

Postural Deviation	#	Movement	Action	Recommended by
Posterior pelvic tilt	1	Hip Extension (left)	Stretch	System
	2	Hip Extension (right)	Stretch	System
	3	Hip Flexion (left)	Contract	System
	4	Hip Flexion (right)	Contract	System
	5	Trunk flexion	Stretch	System
	6	Trunk lumbar extension	Contract	System
Translation of the head (right)	7	Neck head lateral flexion (left)	Contract	System
	8	Neck head lateral flexion (right)	Stretch	System
Extension of the head	9	Neck head extension	Stretch	System
	10	Neck head flexion	Contract	System
	11	Scapula Adduction	Stretch	System

FIG_14

Exercise and Stretching Schedule

Period	#	Name	Movement	Repetitions
Week 1-2	1	Hamstring stretch	1	3X 30 Sec.
	4	Hamstring stretch	2	3X 30 Sec.
	7	Squat	3,4	3x 10-15 Reps
	9	Cobra	5	3X 30 Sec.
	10	Prone lumbar extension with hands on the lower back	6	3x 10-15 Reps
	12	Cervical strengthening	7	10X 6 Sec.
	14	Left lateral flexion	8	3X 30 Sec.
	17	Forward neck flexion	9	3X 30 Sec.
	18	Cervical strengthening	10	10X 6 Sec.
	19	Scapula adductor stretch with your hands behind your back	11	3X 30 Sec.
Week 3-6	2	Hamstring stretch	1	3X 30 Sec.
	5	Hamstring stretch	2	3X 30 Sec.
	8	Unilateral squat	3,4	3x 10-15 Reps
	9	Cobra	5	3X 30 Sec.
	11	Seated lumbar extension	6	3x 10-15 Reps
	13	Supine cervical strengthening	7	10X 6 Sec.
	15	Supine lateral flexion to the left	8	3X 30 Sec.
	17	Forward neck flexion	9	3X 30 Sec.
	18	Cervical strengthening	10	10X 6 Sec.
	20	Scapula adductor stretch with your arms crossed	11	3X 30 Sec.
Week 7-10	3	Hamstring stretch	1	3X 30 Sec.
	6	Hamstring stretch	2	3X 30 Sec.
	8	Unilateral squat	3,4	3x 10-15 Reps
	9	Cobra	5	3X 30 Sec.
	11	Seated lumbar extension	6	3x 10-15 Reps
	13	Supine cervical strengthening	7	10X 6 Sec.
	16	Left lateral flexion with rotation to the right	8	3X 30 Sec.
	17	Forward neck flexion	9	3X 30 Sec.
	18	Cervical strengthening	10	10X 6 Sec.
	20	Scapula adductor stretch with your arms crossed	11	3X 30 Sec.

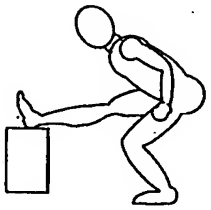
FIG 15

Exercises and Stretching

1 - Hamstring stretch

Position

1. Place the heel of the foot of the working leg on a chair or something of equivalent height so that the leg is flexed at the hip and extended at the knee.
2. Gently flex the supporting leg at the hip and knee. Place one hand on the supporting leg's thigh and the other hand on the outer part of the working leg's thigh.



Action

Flex the supporting leg at the knee until you feel a pulling sensation in the working leg. Hold the stretch for the specified time, gradually relax and repeat as indicated.

Specific Objective

Improve hamstring muscle group flexibility (hip extensors, knee flexors).

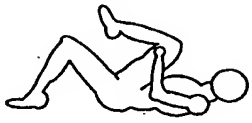
Contraction type:

Static stretch

2 - Hamstring stretch

Position

1. Lie on your back with one leg flexed at the hip and knee, foot flat on the floor.
2. Flex the working leg at the hip and knee, and gently pull it in to the chest with your hands placed behind the knee.



Action

Pull the knee of the working leg in towards the chest, keeping the leg flexed at the knee. When you feel a pulling sensation in the back of the thigh, hold the stretch for the specified time, gradually relax and repeat as indicated.

Specific Objective

Improve hamstring muscle group flexibility (hip extensors).

Contraction type:

Static stretch

FIG 16